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ART. XXVII.—*Notice of, and citations from a Voyage of Discovery and Research in the Southern and Antarctic Regions, during the years* 1839–43, by Captain Sir JAMES CLARK ROSS, R. N., Knt., D.C.L. Oxon., F.R.S., etc.; with plates, maps and wood-cuts. In two volumes, 8vo, pp. 366 and 447. Lond. 1847.

VOYAGES of discovery are among the most interesting and important of the adventures undertaken by man. They have been prosecuted in all ages since the introduction of the mariner's compass, and have been particularly numerous since the middle of the last century. England, France, Russia, and recently the United States, have sent forth exploring squadrons, as well as expeditions by land; their ships have traversed all the great oceans, and have pushed their daring voyages far within the arctic and antarctic circles, amid seas covered with floating icebergs, and in close proximity to the eternal barriers that repel any nearer approach to the frozen poles. The expedition under Capt. Wilkes, which certainly ranks among the ablest and most interesting of these undertakings, we have had frequent occasion to mention with warm approbation. It has done honor to our country, and will ever remain a memorable and illustrious event in its history.

Passing by other recent voyages, we propose for the present, to confine ourselves to the Antarctic Expedition of Sir James Ross; and as this work has not yet been reprinted, we may notice it somewhat in detail. This voyage arose from the recommendation of the eighth meeting of the British Association, held at Newcastle in August, 1838. The principal object proposed was the extension of physical science, especially in relation to terrestrial magnetism, to the importance of which the attention of the Association was invited by Lt. Col. Sabine, and it was enforced by

a committee consisting of Sir John Herschel, Professors Whewell and Lloyd, and Mr. Peacock. These gentlemen presented the subject to the attention of the British government in a series of resolutions adopted by the Association, recommending—

1. A coöperation with the simultaneous observations made and making in Germany and other countries—to be extended to various parts of the British dominions—especially Canada, Ceylon, St. Helena, Van Diemens Land, and the Cape of Good Hope.

2. These observations were proposed to include the direction, intensity and dip of the needle—also, the hourly changes, and on appointed days, its momentary fluctuations.

3. The observations to be made in high southern latitudes, between the meridians of New Holland and Cape Horn, were regarded as particularly important.

The subject was still farther enforced by the powerful influence of the Royal Society and its President, Lord Northampton, who recommended also the establishment of fixed magnetic observatories in various and remote places.

On the 8th of April, 1839, Capt. Ross was commissioned to take charge of the Erebus, a bomb vessel of three hundred and seventy-five tons, of great strength and containing capacity; the Terror of three hundred and forty tons, prepared in 1836 for the arctic seas, being then fitted up so as to be ice-proof, was placed under the direction of Commander Crozier. Each ship had a complement of sixty-four persons, and every provision was made for safety and health: ample means of every kind for accomplishing the objects and meeting the vicissitudes in prospect were supplied in the most liberal manner.

The council of the Royal Society drew up a report, making a small book of one hundred pages, containing a detailed account of every object of inquiry which the diligence and science of the several committees could devise, including geology, zoology, and botany. The most important scientific results of the expedition were transmitted to the Royal Society, and were consigned to their Transactions in the regular course of publication, only passing notices being given in the Narrative.

The Expedition sailed from the Thames on the 30th of September, 1839, and the 5th of October, they bade adieu to England.

In crossing the bay of Biscay in rough weather, they measured the height of the waves which did not exceed thirty-six feet. No bottom was found with from three hundred to six hundred fathoms of line.

Madeira.—Arrived at this island, they at once commenced their magnetic observations. By means of mountain barometers, they ascertained the height of Pico Ruivo to be 6096·08 or 6102·90 English feet, varying with the modes of computation. Captain Wilkes found the height to be 6237 feet above half-tide.

The pile of stones erected by the officers of Capt. Wilkes remained, but the notice attached had been removed.

An aurora borealis with colored streamers was observed beyond the limits of the atmosphere. Several kinds of tea plants were seen in a garden on a mountain, cultivated with many other Chinese plants; the flavor of the tea was excellent.

October 31.—A coming storm compelled the ships, suddenly, to depart; November 4, they saw the Peak of Teneriffe—landed their letters at Vera Cruz and bore away for the Cape de Verds, and passed the tropic of Cancer on the 8th.

The elevation of the plane of vapor was ascertained to be at about 2,000 feet in these tropical regions.

St. Paul's Rocks, lat. 0° 56′ N., long. 29° 20′ W.—These rocks are 500 miles from any continent, and are not in any part more than seventy feet high. There is a crater, according to Capt. Ross, who believes that they have been elevated by fire; but Mr. Darwin thinks them not to be of volcanic origin. They hardly exceed half a mile in circumference.

Soundings were obtained two-thirds of a mile from the rocks, with 300 fathoms of line, but at twice the distance 500 fathoms of line were not sufficient, thus proving the great steepness of the submarine mountain.

December 7th, *the magnetic equator was crossed*, in lat. S. 13° 45′, long. W. 30° 41′, with such precision that the magnetic dipping needles were horizontal at the same instant in both ships, being equally balanced between the northern and southern magnetic systems.

Capt. Ross had some years before seen the needle standing vertical over the northern magnetic pole, and now he looked forward with hope to the time when he should find himself over the south magnetic pole. The change of dip was very regular; at 280 miles north of the magnetic equator the dip was 9° 36′; at 292 miles south it was 9° 52′, the former corresponding to 2·05 minutes, and the latter to 2·03 for every mile of latitude. This large amount of change is confined to the vicinity of the equator; near the poles it requires an approach of about two miles to produce an alteration of a single minute of dip.

Trinidad was seen December 17. The island is a mass of volcanic material, in some parts 2000 feet high. The trap rocks exhibit very extraordinary forms. The Nine Pin rock rises perpendicularly from the sea in a beautifully proportioned column 850 feet high.

The trap rocks on shore influenced the magnetic needles so much as to render the observations useless, while those made on ship board were perfectly correct.

Rain from a clear sky, in a cloudless night, fell for an hour; dew point by Daniel's hygrometer 72°—temperature of the air 74°.

Sounding of the Ocean.—Capt. Ross, provided with a line of 3600 fathoms, or rather more than four miles long, on the 3d of January, 1840—in fine weather obtained soundings with 2425 fathoms of line, equivalent to a depression of 14,550 feet, (more than 2¾ miles,) and very little short of the elevation of Mont Blanc above the ocean. The line was capable of sustaining a weight of seventy-four pounds, and was furnished with swivels to prevent entangiement on its descent. The lat. was 27° 26′ S., long. 17° 20′ W., and only 45 miles N.W. of the place where a shoal was marked on a chart as having been discovered in 1701.

St. Helena, January 31, 1840.—An observatory was erected near the late residence of Napoleon; but owing to the magnetic influence of the volcanic rocks, no accurate results could be obtained, either on land or on board the ships. This proved to be a general fact with the volcanic islands which they visited.

The line of least magnetic intensity was several times passed by the ships in these regions, and by comparison with earlier observations, it appears to have moved northerly during the last fifteen years at the average rate of about thirteen miles per annum.

February 22.—Soon after dark a number of cuttle fishes sprang on board, fifteen or sixteen feet high over the weather-bow; several passed entirely across the ship, and fifty at least were found on the deck.

Waves. Feb. 29.—In a heavy swell the waves were twenty-two feet high, eleven above and eleven below the ocean level; the velocity of the undulations was eighty-nine miles an hour, and the intervals between the waves 1910 feet.

Soundings.—March 3, lat. 33° 21′ S., long. 9° E., soundings were obtained at 2677 fathoms—16,062 feet, or over three miles and one-fourth.

A current of cold water from the eastward passing round the Cape of Good Hope along the African coast, has been long suspected and its existence was now believed to be fully confirmed. Its average breadth is about sixty miles, with a depth of two hundred fathoms—the temperature at two hundred fathoms, sixty miles from the land, being 43°·5, while that of the surface was 61°. The atmosphere vapor, condensed into a cloud of mist, hangs over the stream. It extends only seven or eight miles south of the Cape.

March 17.—*Cape of Good Hope.*—The Cape proved very favorable for magnetic observations, as sandstone is the basis of the country; and every assistance was afforded by the British official residents.

April 11.—*Soundings were obtained* at one hundred and twenty-five fathoms on the Aguilas Bank; but after sailing seven miles on that course there were no soundings at three hundred and

twenty fathoms, and the next day none at six hundred fathoms; so suddenly does the water deepen to the south on leaving the bank.

April 13.—*The variation of the compass* increased to 30° W.

April 21.—*Prince Edwards Island* between 49° and 50° south. Near the East Cape, the lead brought up from eighty-six fathoms, fine sand, coral and corallines. The coast was composed of black, perpendicular volcanic cliffs, much worn by the action of the waves. High mountains in the interior of the island were partially covered with snow.

Penguins, in groups of many thousands each, peopled the shore, and some fur seals were playing in the surf. In Possession Island, one of Crozet's group, called also Penguin Island, the Penguins crowned all the ledges of its rugged shores. The surface rose into mountain masses of volcanic rock with curiously shaped pinnacles and no appearance of vegetation.

Swine in vast numbers occupy Pig Island, so called from its four-footed inhabitants, whose ancestors had been left there by Capt. Distance in 1834. In six years they had multiplied astonishingly, although vast numbers are killed by sealers for immediate use and for salting for their voyages. Goats also in considerable numbers were found on Possession Island, having been left there by American navigators.

On *East Island*, there was a party of eleven men engaged in hunting the sea-elephant, a gigantic seal; they had plenty of food and were contented. The tongue, flippers and part of the carcase of the sea-elephant are eaten by them. Their boots were made of the skins of the penguin, with the feathers turned inward. They were far more filthy than Esquimaux, their apparel being perfectly soaked with oil and smelling most offensively. They find abundance of rock-fish; and the eggs of sea-birds may in the proper season, be collected in boat loads. The egg of the albatross weighs over a pound. Wild ducks are so numerous that trained dogs capture them in any number when they are wanted.

This group of islands is of volcanic origin, and about the tops of some of the hills basaltic pillars were visible. East Island, although not more than three or four miles in diameter, rises at least four thousand feet, and the precipitous shores are several hundred feet in elevation. Off the capes there are detached rocks, pushing half a mile out to sea; one is called from its appearance the ship-rock, another the church-rock, and so on; and one west of the North Cape of Possession Island, is perforated, so that it is said a vessel may pass through it.

May 3.—Lat. 47° 17′ S., long. 58° 50′ E.—The first antarctic ice was seen, only twenty feet out of water, but giving strong premonition of coming scenes.

The albatross, cape pigeon, duck, petrel, and storm petrel in great numbers, gave cheerfulness to the solitary wanderings of the adventurers, and afforded a strong contrast to the dreary stillness of the tropical regions where not a sea-bird is seen except near the few islets, although the ocean abounds with proper food.

May 6.—*Kerguelen Island*, lat. 49° 20′ S., long. 39° 30′ E., was descried; the directions of Cook were relied on and found to be so accurate, that they sailed fearlessly and discovered this small rocky island, when they were almost close upon it; they anchored in Christmas harbor.

This island was discovered in 1772, by a Lieutenant in the French navy of the name Kerguelen, and for several years it excited much attention on account of its being supposed to be a part of a great southern continent. It is bounded by a succession of terraces rising to a height of more than one thousand feet, and Table Mount on the north is 1350 feet high, with the appearance of a crater on the summit. On the north side it has some very perfect basaltic columns beautifully arranged, and their ruins cover the sides and the bottom.

The work by Capt. Ross is fully illustrated by beautiful plates in harmony with its general style; and among them a view of Christmas harbor forms the frontispiece. This harbor has a circular figure, being walled in with a vertical colonnade of trap rock—the point of view from which the picture was taken being six hundred feet high.

On the south side of Christmas harbor is a huge rock of basalt, five hundred feet thick, resting upon an older rock at an elevation of six hundred feet, through which it appears to have burst. Between these rocks were found *fossil trees*, and one of seven feet in circumference was sent to England. The wood is partly silicified so as to scratch glass, and partly combustible, burning freely. A bed of shale six feet thick lay over some of the fossil trees and probably protected them from being carbonized by the molten rock, when it flowed over them. In the arched rock at the entrance of the harbor, fragments of wood much twisted and softer than the silicified wood, are enclosed in the trap—numerous seams of coal are found in the trap from a few inches to four feet in thickness, being thirty feet long in one place and one hundred and fifty in another, where it was in view. The trap rock is of a conglomerate structure, the enclosed fragments being excessively hard and ponderous.

Cumberland bay, a deep inlet of many miles, is bounded by trap rocks, in which are beautiful drusy cavities filled with fine quartz crystals. *Coal* is found in this bay also, in a seam one foot thick and ten feet long; the coal is black and glossy, resembling cannel coal, and does not soil the fingers. Another bed was two feet thick; it burned well and the crew cooked their provis-

ions with it. The superincumbent rock is amygdaloidal greenstone. Coal and fossil wood were found in various parts of the island. Along the basaltic hills the quantity of ruins was enormous, "forming in some places a steep slope of three hundred to five hundred feet down to the black edge of basalt on which the sea breaks."

The *vegetation* is scanty and is described in Hooker's *Flora Antarctica;* it is decidedly antarctic. At a little distance the island appears sterile; but on nearing the shores a belt of green grass is seen to be succeeded by an umbelliferous plant similar to the *Bolax* or "Balsam Bog" of the Falkland Island. Higher on the hills the vegetation exists only in scattered tufts, and almost ceases at an elevation of one thousand to twelve hundred feet. About one hundred and fifty species of plants were observed in all, eighteen flowering plants, three ferns, twenty-five mosses, ten Jungermannia, one fungus, the rest lichens and sea-weeds. The cabbage plant (*Pringlea antiscorbutica*) appears to be peculiar to this island. It was discovered during Capt. Cook's voyage and has proved a highly important vegetable, especially to seamen; it resembles the common cabbage, but contains a large proportion of essential oil which is said to be highly beneficial. It abounds near the sea and ascends to the summits of the hills. The heads are as large as a good cabbage lettuce. The root tastes like horse-radish, and the young leaves or heart, like coarse mustard or cress. The crews of the Erebus and Terror for one hundred and thirty days required no fresh vegetables but this, and for nine weeks it was regularly served out with the salt beef and pork, and during this time there was no sickness on board. Although Kerguelen Island is now destitute even of a shrub, the abundance of fossil wood proves that it was once covered with trees.

There are on the island two species of grass affording nutritious fodder for goats, sheep and pigs, but there are no land animals. Sheep landed by navigators throve wonderfully. The sea-elephants* and other seals formerly very numerous and constantly hunted, are nearly exterminated.

The whale fishery is prosecuted by many hundreds of ships along these shores. Edible fishes are abundant and many new species were found.

Fifteen species of sea-fowl were shot, petrel, penguin, gull, duck, tern, cormorant, albatross, &c. This is a favorite breeding place for the sooty albatross; although late in the season, several full fledged young birds were met with ready to commence their long flight over the Antarctic seas. Ducks were furnished in abundance for the table. The penguins although strong to the taste, made a rich soup resembling that of the hare.

* See the Geology of the voyage, by Dr. Richardson and J. E. Gray, Esq.

Magnetic observations were fully carried out, although during sixty-eight days while the ships were in Christmas harbor, it blew a gale, generally with great violence; for forty-five days the establishment and observers were in danger of being carried into the sea.

Magnetic observations, May 29th and *30th.*—The term-days previously agreed on for simultaneous observations in all the foreign and British observatories, that constitute the great system of magnetic coöperation, were here strictly attended to.

"It happened fortunately to be a period of unusual magnetic disturbance, so that the first days of simultaneous observations proved the vast extent and instantaneous effect of the disturbing power, affecting the magnetometers at Toronto in Canada and at Kerguelen Island, nearly antipodal to each other, simultaneously and similarly in all their strange oscillations and irregular movements." The hourly observations were made without a single break during the whole time the ships were at this island.

The tides rise and fall here not more than thirty inches, and the spring tides are generally less than two feet; the neap tide varies from four to twelve inches.

July 20, 1840.—The ships left Kerguelen Island for Van Diemens Land. Terrific gales and snow storms attended them. Once during a snow squall, the thermometer fell to 27°, although the sea remained uniformly at 36°; the vapor that rose from the water at that temperature, almost instantly froze as it passed over the ships, and kept them constantly enveloped in haze and snow.

Many meteor appearances were seen during a heavy gale, July 27; there was much lightning, and the barometer fell to 28·88; sheets of water broke athwart ships, flooding the decks—and July 30, Mr. Roberts, the boatswain, a man much valued, was swept overboard and drowned, notwithstanding the daring efforts to save him.

During these gales the Terror parted from the Erebus, and they did not meet again until their arrival at Van Diemens Land. Icebergs warned them to be vigilant during the long cold and dark nights of fifteen hours. The winds from the N.W. invariably brought thick weather and snow showers, while clear cold weather, with a rising barometer, attended the S.W. gales.

Magnetic observations were regularly continued during the whole distance of three to four thousand miles, from Kerguelen island to Van Diemens Land; this was effected by means of the excellent apparatus of Mr. R. W. Fox; the instruments commonly in use would hardly have enabled them to make a single observation. They, several times, crossed the isodynamic lines, and on August 6, found the maximum intensity to be in lat. 46° 44′ S., long. 128° 26′ E., being then 2·034 (of the table, p. 104, vol. i), and it diminished to 1·824 at Van Diemens Land.

The westerly variation gradually diminished during this run until August 8th, when in lat. 46° S., and long. 134½ E., they crossed the line of no variation and then the easterly variation as rapidly increased. "The line of no variation, which passes through Australasia, has undergone very little change of position during the last sixty years; and it seems probable that the variation on this spot is about as fixed as on the coast of America."* "We have also reason to believe that at the Cape of Good Hope where the westerly variation has been regularly increasing ever since about the year 1600, when the line of no variation passed through it, at the rate of seven and eight minutes annually, it attained its maximum in 1840."

A terrible storm, August 12th, tore their canvas into ribbons, but they arrived safely in the river Derwent, in Van Diemens Land, August 16th, and to their great joy found that the Terror had arrived the day before them. They remained there two months, and in that time established a permanent observatory called Rossbank by Sir John Franklin, the governor of the Colony. It is in lat. 42° 52′ 27·4″ S., long. 147° 27′ 30″ E., one hundred and five feet above mean tide level, on vast strata of sandstone. Lt. Shay and a party were left to make observations during the absence of the ships in the south.

The mean magnetic dip was 70° 40′ S., and the variation in May, 1841, 10° 24′ 24″ E.

The convicts, two hundred in number, who labored in the excavation of the foundation rock, and the erection of the fixtures, manifested great zeal, and volunteered to labor all night in order to finish the building in season for the observation day, August 27th; and before this time every thing was ready: the whole work, including the delicate adjustments of the instruments, was accomplished in nine days.†

Throughout the twenty-four hours of the 27th and 28th of August, a record was kept of observations in the three elements,

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* Barlow in Phil. Trans. for 1837, p. 71.

† In connexion with this residence in Van Diemens Land, a statement is introduced, respecting the comparative observations and merits of the British, French and American squadrons of discovery, under their respective commanders, Captains Ross, D'Urville and Wilkes. It is to be regretted that so honorable a man as Sir James C. Ross, and that too after an appropriate expression of generous sentiments, should have thrown out an imputation of intended interference in the line of discovery, which Capt. Wilkes has shown by reference to dates and documents, to be entirely without foundation as regards the American squadron (and we believe it has never been proved to be true, as regards the French); moreover the report is wholly untrue, that the British Expedition sailed over any part of the region where land was laid down by Captain Wilkes, the route of Captain Ross being too far to the eastward. But as these matters have been already discussed in the prints—(and in this Journal, vol. v, p. 288, ii series,) we do not incline to go over the ground again, but proceed with the more agreeable task of setting forth the valuable results obtained by the British Expedition as recorded in the interesting volumes before us.

made simultaneously by two magnetometers, once in every two and a half minutes.

November 12, 1840.—The ships sailed again for the south. The *aurora australis* was faintly exhibited about midnight of November 15, in lat. 45° 33′ S., long. 152° 45′ E.

Auckland Islands, lat. 50° 48′ S., long. 166° 42′ E.—These islands are situated between eight and nine hundred miles from Hobartown, (Van Diemens Land.) They were discovered in 1806. After contending with fierce winds from the land, the ships anchored and found a painted board commemorating the visit of D'Urville, March 11th to 20th, 1840, and claiming the discovery of "la Terre Adelaide,"* January 19th to February 1st, 1840, and the determination of the south magnetic pole. Also another board was observed, recording a visit by the U. S. brig Porpoise, March 7th to 10th, on her return from exploring along the antarctic circle, and the icy barrier.

An observatory was established here by Capt. Ross, lat. 50° 32′ 30″ S., long. 166° 12′ 34″ E. The magnetic dip was found to be 73° 40′ E.; the magnetic action of the rock however, rendered the observations of little value. On the passage from Van Diemens Land, there had been observed a gradual increase in the dip; but the first observation on land was two degrees, and the second eleven degrees in error. The rocks had a peculiar ferruginous appearance, and on presenting a fragment "to a delicate compass it turned round and round as swiftly as the hand could move;" it had also polarity, the position of the north and south pole being determined by the direction in which the rock had lain in relation to the magnetic meridian. They were obliged to rely upon the dip as observed on board the Erebus, which was sufficiently removed from the influence of the land, while the Terror was too much affected by the proximity of the diminutive Shoe island. Even at the distance of fifty feet, the needle was made to deviate 2°. Both Auckland and Campbell's islands are composed chiefly of basalt and greenstone, and Deas Head, a promontory of Auckland Island, exhibits fine basaltic columns 300 feet high, which are magnetic. Some of the hills are 1000 and 1300 feet high.

Vegetable productions.—As none of the mountains rise to the snow line, and there are few rocks or precipices, the whole land seems covered with vegetation. Some forests skirt the shores, then comes a broad belt of brushwood, and grass slopes rise to the hill tops. The forest is a dense thicket of stag-headed trees so gnarled and stunted by violent gales of a boisterous ocean, as to shelter effectually a luxuriant under-growth of bright green feathery ferns, and several gay flowered herbs. The trees and shrubs of the north are wanting.

* A part of the great Southern continent.

The woods consist entirely of four or five species of trees or large shrubs, as follows:—*Metrosideros lucida*, a tree with a short thick trunk, allied to the classical myrtle.—*Dracophyllum longifolium*, with a black bark, slender and neat branches and grassy leaves.—*Panax simplex.*—*Veronica elliptica*, a plant of Tierra del Fuego and New Zealand.—*Coprosma fœtidissima*, leaves very fetid, especially when bruised and drying.

The most beautiful plants are found upon the hills—the vegetation being very luxuriant. Eighty flowering plants were found, and fifty of them new.

Mosses, Lichens, Hepaticæ and sea-weeds—more than two hundred, and most of them new. A tree fern was brought on board three or four feet high, with fronds between three and four feet long. The proportion of monocotyledons to dicotyledons was as one to twenty-two.

The domestic pig introduced several years ago and now in a wild state, is the only quadruped, and has greatly multiplied; their food is the Arabia polaris. The birds have come from New Zealand; of land birds there are only seven or eight species.

The albatross breeds in considerable numbers on the tops of the cliffs on a small mound of earth. Its nest is built by the joint labors of both the male and female; it is composed of dry grass and leaves matted together, and is about six feet round at the base and two feet high. Like most of the petrel tribe, the albatross lays but one egg, it is pure white and weighs from fifteen to twenty-one ounces. Two eggs were found in one nest, in only one instance out of one hundred.

Campbell Island was discovered in 1810 by Hazelburgh in the Perseverance, the island is about thirty miles in circumference. The ships found a good harbor called Perseverance, after the ship of the discoverer. It was capable of containing one hundred ships although somewhat shoal in some parts. In entering it they encountered gusts of wind which came down from the heights with astonishing force. This sudden rush of strong winds is characteristic of all the islands in this latitude, and is the more dangerous on account of the light and baffling winds which occupy the intervals between the squalls. At Campbell Island the trees are prostrated by the prevalence of the westerly winds.

Campbell's Island is situated 120 miles to the southward of the Auckland group, but contains fully as many native plants. The whole number of species of plants in the islands, south of New Zealand, is about one hundred, and of these only one-fourth are found in New Zealand, one-thirtieth in Van Diemens Land, and one-sixth in Tierra del Fuego. Campbell Island possesses none of the pines and beaches of New Zealand. It has no land birds.

Departure for the Antarctic.—Fifteen months had elapsed since the expedition left England; but the ardor of the company had in no degree abated, and on December 17th, 1840, they set sail steering directly south, with a moderate breeze increasing to a gale.

In lat. 57° 52′ S., long. 170° 30′ E., the temperature of the water at 230 fathoms was 39°·5, while at the surface it was 42°. It was midsummer in that hemisphere, but the mercury did not rise above 46° at any time in the day.

December 27—the mercury was at 29° all day; many whales were seen; soundings were not obtained at 600 fathoms, and the temperature of the ocean at that depth was 39°·7.

The first iceberg was seen in lat. 63° 20′ S., and others came quickly into view. They were large and solid, with vertical cliffs all around, and their tabular summits varied from 100 to 180 feet in height; large masses were continually falling from them and forming long trains of floating fragments to leeward.

Whales in great numbers were seen—some sperm, but chiefly the black whale,—and they were so tame that any number of them might have been killed. The *Clio borealis* and *Argonauta arctica* were all around, and doubtless here as in the north, formed the food of the whales.

Icebergs became numerous—and in the night amid showers of snow, the first notice of their proximity was given by the roaring of the waves against their precipitous sides.

December 30.—Having crossed the track of the Russian navigator, Bellinghausen, in lat. 64° 38′ S., long. 173° 10′ E., bottom was struck with 1560 fathoms.

January 1, 1841.—New year's day was kept joyously as Christmas had been, and additional provisions and warm clothing were dispensed to the people. The scene was highly exciting, for having now crossed the Antarctic circle, they were fully involved in the pack ice, among whose innumerable masses, whales were seen cruising, and the white petrels were flying about in great numbers.

January 2.—*A berg was seen with a large rock upon it* and nearly covered with mud and stones; the rock when examined proved to be volcanic. On the 4th, in a clear blue sky, the sun illuminated a great number of bergs of strange and curious forms, reflecting its brilliant rays in every beautiful variety of color, and forming, as the ships pursued their devious way among them, a scene of much interest and grandeur.

January 5.—In lat. 66° 55′ S., long. 174° 34′ E., nothing but ice was visible, among which they navigated freely, forcing opposing barriers which only ships fortified as these were could have withstood. Progress was made till they were sixty or seventy miles from its northern edge, and it was fluctuating with the billowy motion, as in thick showers of snow they advanced farther into it. Many seals were seen basking on the ice, and penguins whose

cry the sailors had learned to imitate, responded and followed the wake of the ships in increasing numbers, playing about like porpoises.

During the following three days the ice became more packed, and slow progress was made. In a calm, magnetic observations were made on a cake of ice, which agreed with those on board the ships.

January 9.—They had forced their way into a clear sea; a gale ensued, but there were no icebergs, and it was evident that there was an open space of considerable extent.

January 10.—A violent storm subsided, no ice was visible. They were in lat. 70° 23′ S., long. 174° 50′ E., and the magnetic dip was 85°.

The magnetic pole was now the object of their eager search, but instead of it, while steering south, they discovered land. The *Antarctic Continent* rose in lofty peaks entirely covered with perennial snow; it stretched S.S.W. to S.E. by S., and appeared to be 100 miles distant. They named it Victoria land. Capt. Cook's highest latitude, reached in 1774, was 71° 15′, and this the ships had now attained. As they advanced fifteen leagues towards Mount Sabine, (so named by Capt. Ross after his early friend and patron,) they discovered other mountainous regions extending to the right and left. On the 11th, within two leagues of the shore they observed it lined with heavy pack ice and could find no place to land. A remarkable projection of high dark cliffs was supposed to be volcanic; it was strongly contrasted with the rest of the snow-covered coast, and other rocks several miles to the north showed their black summits conspicuously among the white foam of the breakers. Soundings were made at 160 fathoms and the lead brought up volcanic stones.

The lofty peaks of two magnificent ranges of mountains were covered with eternal snow, and rose seven to ten thousand feet above the ocean. The glaciers that filled the intervening valleys descending from near the mountain summits, projected in many places miles into the sea, and terminated in lofty perpendicular cliffs. In a few places the rocks broke through their icy covering, by which alone they were assured that land formed the nucleus of this, to appearance, enormous iceberg.

Mount Sabine, by several measurements, was found to fall a little short of ten thousand feet, and the other mountains were from seven to nine thousand.

Position of the magnetic pole.—The dip had increased to 86° and the variation amounted to 44°. The magnetic pole was, therefore, inferred to be in 76° S., long. 145° 20′ E., and distant about 500 miles S.W. from their position. The interposition of the land prevented their direct approach to the magnetic pole, and they determined to proceed to the south in the hope of penetrating farther in that direction.

The commanders of the ships with some of their officers, coasted along the shores defended by projecting ice, on which a heavy surf was breaking. With no small peril they landed on an island, to which they gave the name of Possession Island, and found themselves on a beach of large loose stones and stranded ice. In the name of their sovereign they took possession of the country with the usual ceremonies, and no one will ever dispute the right to this region of eternal winter; honor alone is concerned. Possession Island is in 71° 76′ S., long. 171° 7′ E. It is composed entirely of igneous rocks, and is accessible only on its western side. There was no vegetation, but innumerable multitudes of penguins completely and densely covered the entire surface of the island. With their beaks they vigorously attacked the intruders as they waded through their ranks. An insupportable stench arose from the deep bed of guano which had been forming for ages, and which, could it be safely approached, may hereafter be valuable to Australian agriculture. With difficulty they regained their ships; a dense fog, in a few minutes, cut off their view and a gale supervened which obliged the ships to stand off to the open sea. Several days of heavy winds followed, and great numbers of whales were sporting about unmolested, and devouring the molluscous and other marine animals which abound in these seas. In these regions the whales dive under the ice and then come up in the openings to blow.

January 15.—Magnificent views of the mountains were enjoyed with great enthusiasm; the weather was fine and the sharply pointed snow-clad summits, were, by a rough measurement, ascertained to be twelve to fourteen thousand feet high. A heavy swell tumbled in upon this ice bound coast, the ship sometimes pitching her bowsprit under water. Whales and penguins still attended them in great numbers.

One of the icebergs turned completely over and brought up a new surface covered with earth and stones, and in all respects it so resembled an island, that only landing upon it could convince one to the contrary. No harbor could be found for making magnetic observations.

January 16.—They were in lat. 72° 12′ S., and as they proceeded southward, new portions of land came into view; the mountains, seen at a distance of ninety miles, reflected from their icy mirrors, every tone and modification of light.

January 18.—They were in lat. 72° 57′ S., long. 176° 6′ E., and obtained soundings in 230 fathoms; in their nearer approach to the shore they had been found in from sixty to ninety fathoms; as they proceeded, they became 184, 194 and 180 fathoms.

January 19.—In a calm of two hours they dredged at the depth of 270 fathoms and brought up a block of grey granite, of which the usual constituents, quartz, feldspar and mica were

large and distinct, with apparently a fresh fracture as if recently detached. It was probably deposited by an iceberg.

Various other granitic and volcanic masses were raised, and also *living coral;* various corallines, flustræ and marine invertebrate animals were obtained, proving that the bottom of this antarctic sea is affluent with life. Very fine weather and fair winds enabled them to push on rapidly, and at noon January 20th, they were in lat. 73° 47′ S., long. 171° 40′ E.

A high mountain was now seen, believed to be higher than Mount Etna, and it was called Mount Melbourne. The dip now amounted to 87° 39′ in lat. 74° 15′ S., by reckoning, or 74° by observation.

January 22.—At midnight the sun was shining in the south at an altitude of about 2°, in a perfectly clear and serene sky, which above was of a most intense indigo blue.

Dredging in 300 fathoms for two or three hours, brought up many corallines, animals, sand, mud, and small stones, with some entirely new forms of animal life, existing at a depth of nearly 2000 fathoms. Some species that were fished up are common to the arctic and antarctic seas, and if they passed from pole to pole, it must have been through the tropics; but they could not exist in those seas except at a depth of nearly 2000 fathoms. At that depth they might pass from the arctic to the antarctic circle (supposing they could endure the pressure) without a variation of five degrees of temperature, "whilst any land animal at the most favorable season, must experience a difference of 50°, and in the winter not less than 150° of Fahrenheit."

January 22.—The second instance occurred to-day of a rise of the barometer above the mean pressure for these latitudes, followed by a gale of wind and a snow storm. The latitude reached was 74° 20′ S., the highest that had been attained by man, and was the occasion of a festive celebration on ship board.

January 23.—The rising of the barometer during a gale was again observed; it rose to 29·33 at 4 A. M. The land was again in view, but they did not attempt to force a passage to it as they still hoped to reach the magnetic pole by a circuitous route, as the dip had increased to 88° 10′. The mountains called Melbourne and Monteagle were here seen conspicuous, the former crowned by what appeared to be an immense crater, the latter by a pointed summit.

January 26.—In a clear sea, midsummer of this climate, the thermometer was at 24° to 25°, and in heavy weather the spray froze so as to encumber the bows and the rigging. The dip had increased to 88° 33′, so that the magnetic pole was now only 174 miles W. by S.

January 27.—Lat. 75° 48′ S., long. 168° 33′ E., dip 88° 24′, variation 80° 50′ E.

Franklin Island.—With extreme difficulty and peril, Capt. Ross with some of his officers landed upon an island whose icy cliffs, lashed by the surge, rendered a foot-hold hazardous in the extreme, and one of the officers slipping between the boat and the rock was near being crushed and drowned.

This island is about twelve miles long and six broad, and is situated in lat. 76° 8′ S., long. 168° 12′ E.; the rocks are entirely igneous, the cliffs five to six hundred feet high, wholly without vegetation—not even a lichen or sea-weed. Still the white petrel and rapacious gull nested among the ledges, and several seals, but no whales were seen.

January 28.—*An active Volcano, Mount Erebus.*—The lofty land which had been seen the day before, "proved to be a mountain 12,400 feet high above the sea level, emitting flame and smoke in great profusion; at first the smoke appeared like a snow drift, but as we drew nearer, its true character became manifest." The discovery of an active volcano in so high a southern latitude, was justly regarded as a subject of great geological interest, proving as it does, that the antarctic as well as arctic snows and ice-mountains have no influence towards extinguishing the fires that rage beneath, and which, ever and anon, within the polar circles of the opposite hemispheres, burst through the frozen zones and flash upon the ever wintry skies of the coldest regions of the earth. The newly discovered volcano was called mount Erebus, while mount Terror was the name assigned to an extinct volcano to the eastward, little inferior in height, being 10,900 feet high.

Magnetic dip 88° 27′ S., variation 95° 31′ E., being south of the magnetic pole, the ice preventing an access to it. An icy barrier of 150 to 200 or 300 feet high, stretching along many miles, debarred any farther progress in that direction, although the commanders had appointed a rendezvous in 82° S.

"At 4 P. M. mount Erebus emitted smoke and flame in great quantity, producing a grand spectacle. A volume of dense smoke was projected at each successive jet with great force, in a vertical column 1500 and 2000 feet above the mouth of the crater; when condensing, first at its upper part, it descended in mist or snow and gradually dispersed, to be succeeded in about half an hour by another splendid exhibition of the same kind, although the intervals between the eruptions were by no means regular. The diameter of the column of smoke was between 200 and 300 feet, as near as it could be measured. Whenever the vapors cleared away, the bright red flame that filled the mouth of the crater, was clearly perceptible; and some of the officers believed that they could see streams of lava pouring down its sides, until lost beneath the snow which descended from a few hundred feet below the crater, and projected its perpendicular icy cliffs several miles into the ocean."

Mount Terror being much more free from snow, shewed numerous little conical crater-like hillocks, each probably (like those on the flanks of Etna) once in action. Lofty ice cliffs, probably over 1000 feet in thickness, solid without a fissure, and presenting vertical walls to the waves which dashed their foam high against them, stretched away interminably to E.S.E., and the ships sailed along them more than 100 miles without any prospect of passing around them. The latitude was now 77° 46′ S., longitude 176° 43′ E.

The magnetic dip had diminished to 87° 22′ S., proving that they had passed beyond the magnetic pole, and the variation was 104° 25′ E. Soundings were obtained in 410 fathoms with two feet of soft green mud; temperature at 300 fathoms, 34° 2′, in the air 28°; in summer the air and the water seldom differ more than three or four degrees.

A petrel wounded by a shot, falling in the water, was immediately torn to pieces by its companions.

At midnight the lat. was 78° S., in 180° E. long.

Magnetic irregularities.—In lat. 77° 6′ S., long. 189° 6′ E., the dip had diminished to 86° 23′, the variation decreased from 96° E., to 77° E., and then again increased to 16°. It appeared to be one of those extraordinary magnetic points first observed during Sir Ed. Parry's second voyage to the Arctic seas near the eastern entrance of the Hecla and Fury straits.

The highest latitude attained this season was 78° 4′ S., and all progress farther south was prevented by a barrier of ice 160 feet high, and extending in one unbroken line 250 miles.

(To be continued.)

ART. XXVIII.—*On the Fundamental Principles of Mathematics;* by STEPHEN ALEXANDER, Professor of Mathematics and Astronomy in the College of New Jersey.

(Continued from p. 187.)

Of Positive and Negative Signs, and a Particular Case of Imaginary Values.

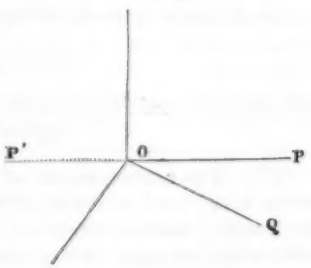
(17.) The consideration of the algebraical signs of quantities seems to be next in order, after what has already been exhibited, with regard to their division; for the relative greatness of the portions obtained, and the *manner* in which the greatness of the quantity will be affected by that of another in any given case of combination, will depend upon their respective signs; while neither the absolute, nor yet even the relative greatness of the quantities, will be affected by those signs.

Thus -2 indicates the subtraction, or at least the negative relationship, of *neither more nor less* than $+2$ (the negation of neither 3 nor 1 would answer the purpose) and $-Q$ indicates the subtraction, or at least the negative relationship of *as much as* $+Q$, *and no more.* In neither case can one of these quantities produce in a like combination a greater or a less effect than its own negative would produce; but that negative in such a combination (*because* it is *negative*) will be *destructive* to *precisely the same* extent to which the positive quantity is *constructive.* Hence, a negative quantity ($-Q$) cannot be regarded as being *in fact* less than *nothing* (i. e., (14) as less than the *zero of its own species*), but only as being *in effect* less than the zero of the species, in one particular respect; viz. *that very respect, in which the other quantity* ($+Q$) is *positive.* For *the zero* is *nothing* in that *specific* respect; while the negative quantity ($-Q$) is precisely as great indeed as $+Q$, but of an opposite *character* in the *very respect* in which $+Q$ is positive; insomuch that $+Q$ would be precisely destroyed by $-Q$; i. e., annihilated or reduced to *the zero of the species.* Or (as viewed in the opposite direction) $+Q$ would be precisely adequate to the destruction of $-Q$, reducing *it* to *the zero;* and a second similar introduction of $+Q$ would, in place of this last result of *the zero*, give $+Q$ itself: or, it appears, that $-Q$, in *the very respect* in which $+Q$ is positive, is *in effect*, as much below *the zero of the species*, as $+Q$, in the positive sense, is above it.

Similar principles will be applicable to the results of like combinations of other quantities with the respective quantities, $+Q$ $-Q$ and *the zero;* the respective results being represented by $+fQ$, no result, or *zero* (*of the same species with* $+fQ$,) and $-fQ$.

In the determination of the position of a point in space, reference, as is well known, is made to three coördinate axes, all meeting at one point—the origin. If from this origin O, we measure outward upon any of the three axes, we naturally mark the measured length as positive; since it increases as we proceed in that direction in space. If we measure from P toward O or P′, any distance less than PO, the quantity thus measured will thereby be taken from PO or will have an effect, the negative of the previous increase. If we thus measure from P a distance equal to PO; this distance will extend to the origin; and PO will be subtracted from itself, leaving no remainder; i. e., PO will be reduced to a point, or the *zero of*

Fig. 1.



length. If (still in the same direction) we measure from P a distance such as PP′, greater than PO, the farther extremity of the line so measured will extend *beyond* O to P′, i. e., to a distance equal to the excess of PP′ above PO; or the attempt to subtract from PO a quantity *greater than itself*, will result in a *negative* remainder equivalent to the excess of the greater quantity PP above PO; and this remainder will extend from O itself, in the direction *opposite* to that of OP. If PO = *zero*, the *whole* of PP′ will in this manner, extend from O in the negative direction.

The negative quantities thus originating are, in all the respects specified, strictly analogous to those which present themselves when the attempt is made to subtract 7 from 4, or 9 from 6, or, in general, the numerical quantity n from q, when n is greater than q;* the differences in the results of such subtractions being no other than those which must exist in the case of quantities of another species.

The same reasoning will apply to distances measured, in like manner, upon either of the other axes. Hence distance outward from the origin, in the direction first assumed, will in any case be naturally positive; and distance in the opposite direction, negative; and will be exhibited in its *isolated* as well as negative character, when measured in that direction, beginning at the origin.

These conclusions being independent of any particular inclination of the axes among themselves, will apply to the case of three axes the sum of whose three angles—that of first axis with second, second with third, and third with first—differs scarce at all from four right angles; and this, whether those three axes be situated on the one side or the other of a given plane of reference, passing through the origin O. As, therefore, the conclusions referred to will be applicable, however near the state of things may approach to that in which the three axes would be all in one plane, and this, on either side of that state of things as a limit; these same conclusions must be regarded as true in the case of that limit itself: or direction from the origin outward must be regarded as positive, whichever of the three axes may be employed to indicate it, and the contrary direction be regarded as negative, *even when carried beyond the origin by excess of distance extended in that direction:* the three axes being moreover all in the same plane.

As, moreover, the conclusions, from first to last, are independent of any fixed direction of one or more of the axes, they will all be alike applicable to any other three axes, which like OQ do not coincide with any of the first three; direction from

* The view here presented will be found to coincide with that of *M. Faure*—"*Essai sur la Théorie et l'Interprétation des Quantités dites Imaginaires, Premier Mémoire*, (16.) *a Paris*, 1845." As M. Faure moreover intimates [*Essai, &c.*, (19.)], the distance subtracted from OP may be regarded as measured *negatively* from a *new origin* at P; precisely as OP′ is measured *negatively* from O.

the origin outward being still positive and the contrary negative, &c., in the case of any such axis; all the six axes being moreover in the same plane. What has thus been extended from the case of three axes thus situated to more than three, may in like manner be extended to any number of axes however great. Hence direction outward must be regarded as positive on any and every straight line drawn from the same origin, in the same plane, and the contrary direction must be regarded as negative, even when it extends, *after that manner, on the contrary side of the origin.*

We have, thus, exhibited *the foundation for the analytical necessity of regarding a radius, or a radius-vector, as positive, when measured outward from the centre, or pole; but negative when measured in a contrary direction, even when, after that manner, it is regarded as extending across or beyond that centre, or pole.*

(18.) The doctrine of "imaginary quantities" would be next in order; but this, of itself, would furnish matter for an entire dissertation; if it were even advisable to enter upon the consideration of a subject, so much and so often discussed.* It may not however be amiss to advert to one or two results of analysis which seem to admit of explanation, by a reference to the principle, that imaginary quantities, occurring in a geometrical investigation, may sometimes have a possible existence out of the plane of reference. Two equations first discovered by Euler,

$$\text{sin. } x = \frac{e^{x\sqrt{-1}} - e^{-x\sqrt{-1}}}{2\sqrt{1}}, \text{ and cos. } x = \frac{e^{x\sqrt{1}} + e^{-x\sqrt{-1}}}{2},$$

when transformed, by substituting for the real arc x, the imaginary arc $x\sqrt{-1}$, give, respectively,

$$\text{sin. } (x\sqrt{-1}) = \frac{e^{-x} - e^{x}}{2\sqrt{-1}}, \text{ and cos. } (x\sqrt{-1}) = \frac{e^{-x} + e^{x}}{2}.$$

Here the cosine is real, though the sine and the arc are both imaginary. This seems to arise from the fact that the cosine might, *in effect*, be found in *the common intersection* of the plane of the imaginary arc $x\sqrt{-1}$, and that of the axes of reference. It, therefore, has a real value; while the sine and arc, being both out of the plane of the axes, are imaginary. This being admitted, the secant of the real arc (i. e., the arc whose cosine has this real value) will $= 1 \div$ by the value of the cosine; while the secant of the imaginary arc having the same cosine must, it would seem, $= \sqrt[n]{-1} \div$ by the value of that cosine; unless the imaginary arc were reduced to the limit of 0°, or 180°, or 360°, &c.; when it would be terminated in the plane of the axes: when also its sine must $= 0$.

* See among others, the "Essai" of M. Faure, (already cited in (17.).)

Of Infinites of Various Descriptions.

(19.) (*a.*) We shall designate a quantity as being ***absolutely infinite;*** if it be so great as to be ***utterly boundless or destitute of any limit.***

This is the case with "absolute space;" which whether we regard it in a direction forward, or backward, or upward, or downward, or sidewise, or obliquely, is, in any and every direction, positively boundless or absolutely infinite.

So too, far back as the imagination can extend—antecedent to all ages past, antecedent to the existence of all created beings or things—we still behold, self-sustained on the throne of his adorable perfections, the GREAT FIRST CAUSE; who being the very origin of the first beginning, HIMSELF has none; but ever was, as now, "*from everlasting.*" It is in this underived antecedent, this perpetual precedent, of the *Divine Pre-existence,* that we find the realization of *Eternity Past.*

For also beyond the ages to come—unmeasurable though they may be "by the flight of years"—must still endure the ceaseless and unalterable being of HIM "who alone hath immortality" underived: and, *in that,* is Eternity Future. Yet what mental vision shall penetrate the "clouds and darkness" which surround the Divine Pre-existence; and inform us how it was, that, in Eternity Past, time e'er began. Or—fixing its unfaltering gaze upon "the light inaccesible" which covers, as with a veil of "glory," the designs and capabilities of the future—say what means the duration of an immortality once begun in his presence? Yet is it the combination of both these, of that eternity which always was, and that which "ever shall be"—nothing less than this, nothing short of it—that constitutes *the absolute infinite of duration?* It is the inexhaustible fullness of the being of HIM "who inhabiteth eternity," in its twofold sense; having ever been, as now, "*from* everlasting *to* everlasting."

(*b.*) We shall designate a quantity as being ***specifically infinite,*** if it be as boundless as those already described, *in certain respects only.*

Thus if a straight line be without termination, in either direction, from a point which might be assumed in that line, such a line will be specifically infinite; viz., in length—in which respect alone a line can be great or small. In this same respect might a surface be said to be infinite, on which such a line could exist, or the solid within or on which such a line would be possible: whatever might be the other dimensions of either the surface or the solid.

[If a line, alike interminable, were any where curved, such a line must be regarded as *longer* than the other; since it would intrude upon what may (by indulgence) be termed the *breadth*

of absolutely infinite space, as well as extend through what, for want of a better term, must be called its length.]

A surface without border would be specifically infinite in length, breadth, and a contiguous and plane superficial area.

[A surface without border and altogether plane, must, notwithstanding, be regarded as less than another surface, which though alike without border, yet deviates any where from a plane; since the latter not merely extends through all space in every direction which can be called length and breadth, such as exist upon a plane, but also encroaches upon what we may, in such a comparison, term the *thickness of space.*]

The quantities here characterized as specifically infinite are innumerable; and some may be parallel to one another: while, in so far as we can discern, there is but one absolute space; i. e., *one absolute infinite of extension.* So also there is but *one absolute infinite of duration.*

(*c.*) We shall designate a quantity as being, in comparison with another, *relatively infinite;* if the ratio of the quantity to that other be too great to be expressed by any assignable number, however large.

Any assignable number, however large, may be exceeded by the continued addition of the number 1 to itself; and then again to the sum, &c. &c.; and the like must be true with regard to any series or aggregate of the units of any species; when the number of units is assignable. But if, instead of continually adding the original unit, or its equivalent, we take its double, and of that product *its* double, &c. &c., and continue the process of successive doubling, until the *number* of such individual *processes* is as large as any number which we can assign; the aggregate will far exceed that obtained by successive additions, repeated as often.

For in the one series, the quantity to be added, at each successive step, is constant; so that if Q denote the original unit, the aggregate of the series or

$$S = Q + Q + Q + \&c. \ldots\ldots;$$

but in the process of continued doubling, each term consists of the aggregate of all that preceded, added to as much as itself; and therefore the sum of such a series, or rather the resulting aggregate,

$$S' = Q + Q + (2Q) + (4Q) + \&c. \ldots\ldots;$$

the terms after the second continually increasing. If then the number of *terms* in each series be as great as any that we can assign, the number of *times* the original quantity Q contained in the aggregate of the second series will be *too great to be assigned;* and will in any case exceed the number of units such as Q, which we may assign to the first series, however great that num-

ber may be. An aggregate such as S′ would then be relatively infinite in comparison with Q.

The like must, *a fortiori*, be true, if, in any or all of the processes of successive multiplication, the multiplier were more than 2; so that the multiplicand would be more than doubled.

If, by an inverse process, there were taken from Q its half, and then from the remainder its half, &c. &c., a sufficient number of times, we should, in the end, obtain a quantity so small, in comparison with Q, that no multiplier of it could be found sufficiently large to reproduce as much as Q.

For in this case, if the *number* of individual *inverse processes* were equal to that of the direct processes in the former case, and L be the last remainder; then, beginning with L, we must, in effect, repeat the process of continued doubling as often as before, in order to reproduce as much as Q; or Q will itself be relatively infinite in comparison with L; or L will be "an infinitesimal" in comparison with Q.

The like must be true, *a fortiori*, if at any step in the process, more than half were removed.

As, moreover, Q is relatively infinite in comparison with L, and S′ again relatively infinite in comparison with Q; so again, by continued doubling, beginning with S′, might another aggregate be obtained, which would be relatively infinite in comparison with S′, &c. &c. On this it is unnecessary to dwell; as one mode of exhibiting the differential calculus, owes its peculiarity to the employment of quantities such as these.*

It is important however to observe, that this description of infinity is the only one which can be predicated of *number*, *velocity*, *mere mechanical force*, &c. &c.

For no number can be so great, that a sum of units *might not exist*, (1.), which should exceed that number.

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* It may not be amiss, here, to notice an argument against the consistency of the results of mathematics which may be thus exemplified. An inch may be divided, and the remainder subdivided, &c., by the process already explained, and thus the infinitesimal of an inch obtained; and the aggregate of all such infinitesimals into which the whole inch might be divided, would be equal to the inch itself. Now if the inch were passed over by a moving body, the passage over each infinitesimal would occupy some portion of time. But the number of such portions of time would be infinite; since the number of the infinitesimals of the inch is infinite. Hence (says the objector) it must require an *eternity* for a body to move over an inch—which is absurd. The conclusion is indeed absurd, but *that* conclusion follows not from the premises. For as the inch is relatively infinite, i. e., infinite *in comparison* with its infinitesimal, in the restricted sense of relative infinity; but still finite and capable of measurement by a comparison with other standards; so the time requisite to pass over an inch with a uniform velocity, will be relatively infinite, i. e., in comparison with the time in which the infinitesimal of an inch would thus be passed over; while *it* also might be finite and capable of accurate measurement by a comparison with another standard. This portion of time then could only be called a *relative* eternity; if that were not an abuse of the term. If the whole inch were traversed in a minute, this relative eternity would endure but for a minute; while it would still be true that the infinitesimal of an inch would be traversed in an infinitesimal of that minute.

And no velocity could be so great, that the body moved would be in two places, at the same instant; for that would contradict what all experience has shown to be true of the nature of body. Hence the transfer of a body from one place to another, however rapid, must occupy some time: and it is mathematically *supposable*, and, for aught that can be discerned, physically possible, that the body might be made to pass through or over a greater distance in the same time; i. e., any velocity, even that which is too great to be measured, might admit, it would seem, of an increase.

So also, however great a mechanical force may be applied in any case; another might (for aught that can be discerned) be added to and combined with that force.

(20.) It may be observed in brief that the three descriptions of infinity obtain respectively, thus:

1st. *Absolute infinity*, when the quantity is so great that there is no limit to it.

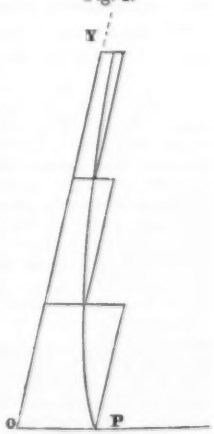
2d. *Specific infinity*, when this boundlessness exists in certain respects only.

3d. *Relative infinity*, when the one of two quantities of the same species is too great to be measured by the other.

Of Finite Quantities which are specifically infinite in one Dimension.

(21.) The results of the *Integral Calculus* have long since indicated that certain areas whose *limits* in part are lines *interminable in one direction*, may yet themselves be finite. Such are the areas bounded, in part, by certain curves and their asymptotes. An area may also exist having for its partial limits straight lines, and on one side a line interminable in one direction, or even in both directions, and thus, (19.), specifically infinite; and yet, as it would seem, be finite in surface. Such an area will exist, if the arrangement of its portions be that represented in the figure; each parallelogram having its sides in one direction equal, each to each, to those of any other which are situated in the same direction; but each having its sides, respectively, in the other direction, but one half of the length of those which immediately precede them, in the series. Then if Q be the area of the first parallelogram, or that represented as lowest in the figure, the sum of the "infinite series" or

Fig. 2.



$$S = Q + \tfrac{1}{2}Q + \tfrac{1}{4}Q + \&c. \ldots\ldots = 2Q;$$

the line OY being supposed to be interminable in the direction of

Y. If a similar construction should exist downward, or in the opposite direction, the sum of the areas of both would still be *finite;* it being equivalent to 4Q; but the limit of the surface along OY would be a straight line, (19.), *specifically infinite.* This last must be true, since S would still differ from 2Q, (being an infinitesimal less than it,) if OY produced were only, (19.), relatively infinite: it will be equivalent to 2Q only in case the border or limit OY really have no termination in the direction of Y.*

Comparison and Contrast of a Finite Quantity with the Infinite of its own Species. Relative Zero.

(22.) The distinctions of the various infinites having now been exhibited, we may be the better prepared for the comparison of a finite quantity with an infinite of its own species.

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* If a curve be drawn as in the figure, this curve will be the ordinary hyperbola, and OY its asymptote. Now the *Integral Calculus* will indicate that the area bordered by OP, OY, and the curve is *not finite* when the two latter are interminable in the directions in which the approach of the one to other takes place. Yet this area is less than that of the other surface already described; a portion of that other surface being left out by the construction of the curve: i. e., the area bordered by the curve is less than 2Q; or *it must be finite.* Here, then, is *a paradox.* May it not be true that in this case a concealed term exists in *the constant* which must be introduced, in the integration; especially since the equation applicable to this case, if integrated according to the rule for the integration of differential quantities containing a power of the variable; will exhibit infinity in the result: it being in fact the excepted case; which however may be made to exhibit a finite result, when integrated by the aid of logarithms.

The equation of the hyperbola, the asymptotes being the axes, is

$$xy=\frac{A^2+B^2}{4}=q. \quad \text{Hence,}$$

$$x=\frac{q}{y}, \text{ and } dx=\frac{-qdy}{y^2},$$

$$\therefore ydx=\frac{-qdy}{y}=-qy^{-1}dy;$$

which is the excepted case.

M. L'Abbé Moigno (*Leçons de Calcul Différential et de Calcul Intégral,—Calcul Intégral,* 1*re Partie,* 16.) disposes of the excepted case, in the general, thus: Le second membre de la formule,

$$\int x^m dx=\frac{x^{m+1}}{m+1}+C$$

semble devenir infini pour $m=-1$; mais comme on peut l'écrire sous la forme

$$\int x^m dx=\frac{x^{m+1}-a^{m+1}}{m+1}+C;$$

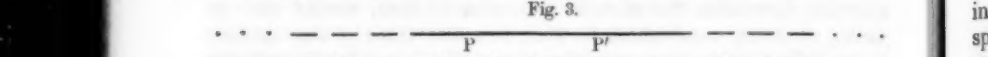
il devient réellement indéterminé; on obtient sa veritable valeur en prenant le rapport $x^{m+1}\log. x-a^{m+1}\log. a$, des dérivées du numérateur et du dénomenateur, et y faisant $m=-1$, ce qui donne

$$\int x^{m-1}dx=\int\frac{dx}{x}=\log. x-\log. a+C=\log. x+C,$$

comme on le sait *à priori.*

If a point (P) be assumed in a straight line, (19.), specifically

Fig. 3.

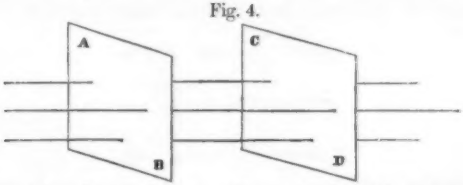


infinite, the line in either direction from that point will be interminable; and the two portions (if they may so be called), one on each side of the point, may be regarded as being, *in effect*, equal. If, again, another point (P′) be assumed in the same line, however remote from the former, the two portions, one on each side of it, may again be regarded as being, in effect, equal; though the whole intervening distance (PP′) will have been added to one of the portions into which the line was divided at the first point (P) and subtracted from the other portion. It appears therefore that any such distance, *however great*, must be regarded as *nothing* in comparison with a straight line interminable in only one direction.

Similar reasoning applied to the case of any other of the specifically infinite quantities described in (19.); (or rather to what in like manner may be regarded as being in effect their halves,) would lead to a similar conclusion with respect to them.

If moreover a plane without border be extended any where in space, all that region of absolute space on the one side of the plane must be regarded as being, *in effect*, the half of all space, and all that region on the other side of the plane, as being, *in effect*, the other half of the same. But the like will be true of the regions found, the one on one side, and the other, on the other side of a plane of the same description, parallel, it may be, to the former, but at any distance from it, however remote; the one

Fig. 4.



being without border and coinciding, in direction in space, with AB; the other alike without border, but coinciding, in direction in space, with CD. But if the dividing or separating limit be at one of these planes, instead of the other, all the intervening space will, as it were, have been added to the one half of all space, and taken from the other. Yet the two regions which are separated by the second plane of which CD is a part, are still to be regarded as being, *in effect*, equal, or each as still, *in effect*, the half of all space.* Hence, all the intervening space separated from the

* In this as in other instances it will be observed, that the truth arrived at, in so far as the so-called halves are concerned, admits of being otherwise illustrated. When a straight line such as PP′ in the figure at the commencement of this article (22.) is finite, the middle is at an equal distance from each end.

But when the line is interminable in both directions, there is no extremity in either direction to measure from, and thus determine the middle. The middle

rest by two planes without border, must be regarded as *nothing* in comparison with the so-called half of all space; though in the space so separated there would be room for all the visible creation, could its form be adapted to the dimensions of that space in those respects in which the dimensions are finite: or the two planes might themselves be supposed to be situated outside of all that we can discover by the best optical aid; and the conclusion still be the same; viz., that the whole space separated by them must be regarded as nothing in comparison with all space; which is itself absolutely infinite.

In the space thus separated, might also exist all the specifically infinite quantities described in (19.)

As the point assumed in the interminable line, *in effect*, divides that line into two halves; and the plane without border in like manner divides all space, so (19.) the instantaneous present divides the Eternity Past from the Eternity Future. It does so (in so far as can be discerned) in all worlds at once; as the same plane in the figure cuts all the three straight lines which penetrate it, and which are to be regarded as interminable in both directions from the dividing plane. The present thus divides those two Eternities now. So, also, it was, in so far as can be discerned, after the first moment of the existence of the first created being or thing, and thus it shall be, after the present system of things, like a worn out "garment," is, as it were, "folded up" and laid aside.

Through the limit thus ever present the current of time passes, in a metaphorical sense; and, moment by moment, the Eternity Future is transferred to the Eternity Past. [We seem to recognize this even in our ordinary language. Thus we say, when to-morrow comes (viz., to us) and not when we come into to-morrow.] As, moreover, in the case of the analogous quantities in space, so, in this case, the transfer, whether of a single day, or of countless ages, from the one Eternity to the other, will be found to leave each of those Eternities *in effect* the half of, (19.), the absolute infinite of duration. Hence in manner as before, all the

being thus actually indeterminate, may exist, in so far as it exists at all, any where in this line.

The like may be said of all space, which has no borders. Or—with reference to its boundlessness on all sides—that its centre is any where.

A line interminable in one direction may, as already intimated, be regarded as the half of the line interminable in both directions;—but it does not seem to be possible to obtain in the same form any quantity which could be called the one-third, or the one fourth, &c., of the whole. Yet if an interminable curve be supposed to exist of such a form that it might throughout meet the interminable straight line, and, any and every where along it, be found finite portions of the curve, each equivalent to $1\frac{1}{2}$ or $1\frac{1}{3}$, &c. times the corresponding fraction of the straight line, a fraction such as $\frac{1}{2}$ or $\frac{1}{3}$ of the interminable straight line would seem to exist combined with the whole and all expressed together by the interminable curve. It would *seem* to be so; but any such conclusion should be received with caution.

intervening portion of duration thus transferred must be regarded as *nothing* in comparison with either Eternity.

We may thus in some very humble measure learn how it is, that, in the view of the INFINITE MIND, "a thousand years" should be "as one day, and one day as a thousand years."

(23.) A finite quantity in comparison with others of the same species, which are in some respect boundless, has, (22.), been found to be as nothing. We shall therefore designate it in this comparison as *a relative zero;* it being *zero by comparison*, in a more *intense* sense, than the quantities described in (19.) were *relatively infinite*, in *comparison* with others beneath them; and also a more *intense* sense than the same quantities were *infinitesimal*, in *comparison* with those above them.

Character of the Symbols $\frac{1}{0}$ *and* $\frac{0}{0}$.

(24.) If the straight line described in (22.), as interminable in one direction, be assumed as a measuring unit, then any finite straight line being, (23.), a *relative zero*, we shall have for the symbol of the ratio of the greater of these quantities to the less $\frac{1}{0}$; and for that of the less to the greater, $\frac{0}{1}$.*

Since, moreover, the finite straight line is a relative zero, (the line interminable in one direction being the standard); if p denote the length of one finite straight line, and q that of another, we shall have in manner as before,

p represented by or $=\frac{0}{1}$; and q represented by or $=\frac{0}{1}$; whence,

$$\frac{p}{q}=\frac{0}{0}.$$

Or more directly still; p being *relatively* represented by *zero*, and q by the same,

$$\frac{p}{q}=\frac{0}{0};$$

as before.

From this equation, however, neither p nor q can be determined; nor even the *actual ratio*, of the one to the other.

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* The line interminable in one direction is, moreover, either the secant of the tangent of 90°; or, when taken negatively, it is either the secant or the tangent of 270°; and radius of the circle being 1, we have tan. $90°=\frac{\text{sin. } 90°}{\text{cos. } 90°}=\frac{1}{0}$; and sec. $90°=\frac{1}{\text{cos. } 90°}=\frac{1}{0}$; results agreeing with the preceding determinations, when the greater line was regarded as *the unit*, and the less became *a relative zero*.

The indeterminate character of the symbol $\frac{0}{0}$ *is thus established by primary considerations.*

[In the case now described the symbol or form $\frac{0}{0}$ presented itself, because the terms were *zero* in *comparison* with a standard unlimited in at least one respect. In the instance of a fraction such as that represented in the equation,

$$\frac{Fx}{fx} = \frac{P(x-a)^m}{Q(x-a)^n}$$

which, when $x=a$, becomes,

$$\frac{Fx}{fx} = \frac{P\times 0}{Q\times 0} = \frac{0}{0};$$

the form or symbol $\frac{0}{0}$ appears, because the particular value of x reduces each of the multipliers, $(x-a)^m$ and $(x-a)^n$, to *zero*. Hence *no product* can, in effect, result, whatever may be the value of the multiplicand; i. e., (14.), *nothing* will be found in the place of the numerator as well as that of the denominator: or the value of the fraction, in its form of $\frac{0}{0}$, becomes indeterminate, not as in the former case, because of the character of the standard of reference, but because of *the actual disappearance* of every thing from both terms of the fraction, which under other circumstances, could render them *definite*.]

Another Application of Preceding Principles.

(25.) [The relations of things being, as already maintained in (4.), *constituted relations*;—and they also being constituted in some respects alike, as appears from the comparisons between those of space and time in (22.)—we may even reverentially proceed a step farther, and conclude, that, as any finite (or even in some respects boundless) space is *worthless*, or to be regarded as *good for nothing*, *in comparison* with the *absolute infinite of space*; and as, again, any finite portion of duration is also *a relative zero*, in comparison with *the absolute infinite of duration*; so, also, must the highest created intelligence and lowest among men be *alike worthless* or regarded *as nothing* in comparison with the ALONE INFINITE ONE: or man, placed as it would seem lowest in scale of such intelligences, must be represented, in comparison, as being as it were "less than nothing." This truth has important moral bearings; but this presentation might be regarded as out of place in a mathematical dissertation.]

Wherein Necessary Truth is to be found, and the Final Hypothesis.

(26.) The consideration of the two great relations of things, duration and space, has often prompted the question whether, if the visible universe were annihilated, space would remain?

On the one hand—since the limits of things actual are, (8.), no part of those things; but their surfaces, as connected with the things themselves, bound them and are removed whenever and wherever those things are transferred; yet cannot be removed *from* the things, and thus placed by themselves—it would seem, from all this, that what is less a relation of things, would, if those things were gone, not exist *by itself;* or *no longer be.*

On the other hand, surface, &c., are *dependent* relations of things—as must appear from what has just been stated—while space is independent of them, in so far, that when the thing is removed the space, (15.), which it occupied, is forsaken or left behind; and may be again occupied by something else. Hence, it would seem that, if all such things were gone, space would *still be.*

Certain it is, moreover, that, in so far as we can discern, if the visible creation were annihilated, there would be room for another. But does this conclusion amount to anything more than the assertion, That, under the new system of things, space would again exist as a relation of them; as it does now? If so, then this cannot determine what would be, if there were *no* such things. It appears then that such a state (or rather absence) of things is so far without the pale of our experience, that we can form no adequate idea of it; and must therefore leave the question of the existence or non-existence of space, in the absence of such a creation as we now have, without an answer.

But whatever the reply to that question ought to be—space exists not, nor can it exist independent of the GREAT FIRST CAUSE, who formed all things, and "by whom they also *consist;*" with whose existence, moreover, the absolute infinite of duration, (19.), is interwoven.*

Could space, indeed, exist independent of HIM, or does it so exist, then it exists not of "his good pleasure"—then was it not *created*—then must it be *self-existent*—but then must it, also, be found *in* HIM; which contradicts the hypothesis: and that hypothesis must therefore fail.

We know therefore of no space which is not pervaded by his presence, as we are certain that there is no duration which "He inhabiteth" not.

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* If it were imagined that *duration* might exist, *though* THE FIRST CAUSE *were not*, —the reply must be that the hypothesis of HIS non-existence is itself the greatest possible absurdity—to say nothing more.

The relations of things, as we have them, will remain the same while HE is pleased to continue the present constitution and arrangement of things. *Unalterable*, then, these relations must be; but, being the opposing of "his good pleasure," they cannot be *necessary;* for then, as already shown, they must be regarded as interwoven with his own existence: i. e., existing as the necessary relations of his being, which is itself necessary.*

To suppose these relations, or even the most abstract truths respecting them, to be *necessary*, would be to make them not the *relations* of things or beings, (or ultimately of the ONE SELF-EXISTENT BEING,) but *existences or things themselves*. If they existed *necessarily* and, of course, previous to a creation, *where* and *how* did they exist; unless in the discernment and prescience of the DIVINE MIND? The admission that they could exist *only there*, will itself be the full admission of all that has been asserted. *Truth*, *beauty* and *goodness*, then, are but the outflowings of his adorable perfection—of his infinite excellence; and their "*eternal*" laws are but transcripts of the same. Because of that perfection and excellence HE is gloriously above all control; and the origin and rule of all that is true and right, exists neither *above* nor *beside* HIM, but is found *in* HIM.

In his self-existence, therefore, as it "was, and is, and is to come," is to be found THE *one, the absolutely necessary truth:* all others are contingent, just so far as HE has made them so. Herein, is to be found, moreover, *the great, the final hypothesis*, upon which rests *the structure of the universe;* and which, too, undergirds and sustains that universe, in *all its relations*.

ART. XXIX.—*Results additional to those offered by Dr. Locke from his Three Experiments, "On Single and Double Vision produced by viewing objects with both eyes;"* by S. PEARL LATHROP, M.D.

FEELING an interest in the various branches of optics, I read with much pleasure, the article "On Single and Double Vision, &c.," by Dr. John Locke, in the January number of this Journal. Having acquired, as he says of himself, the power of voluntary convergence of the optical axes to an *extreme* degree without the aid of viewing near objects, I have verified the several experiments mentioned by him.

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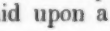
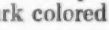
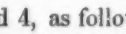
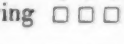
* The seeming contradictions, *if any*, which this might involve in the case of truths called axiomatic, must be regarded as but *seeming;* and as arising from our inadequate comprehension of the relations in question, and inexplicable for reasons which may, perhaps, be similar to that which prevents us from discerning *how*, in eternity past, time e'er began; though we cannot escape from the belief of *the fact*, that it *somehow* occurred.

In performing the second and third experiments, I found, in *addition* to what is mentioned by Dr. Locke, by a still greater degree of convergence of the optical axes, other results of an interesting character. The second experiment is the following: Two candles of equal size and height were placed side by side on a table, and, by converging the axes of the eyes, four images were produced. As the convergence progressed, each pair of images receded gradually from the original place of the single image until the two contiguous ones—the second and third, approached, and finally coalesced into one, when three images only were in view. This he illustrates in the following manner, using letters, in the place of which I have substituted squares, representing the pieces of paper which I employed in performing the experiments. These were laid upon a dark colored spread. Thus: No. 1. —Natural single vision. No. 2.  —View with axes slightly converged. No. 3.  —View with greater convergence of the optical axes and the two intermediate images coalesced into one. By a still greater convergence, I have found that the second and third images—now coalesced—can be made to pass by each other, when four images will again be seen, as follows; No. 4. . As the convergence commences, these intermediate images are seen to recede from the place of the original images, when four images are seen, as in No. 2; then to approach one another and coalesce, when three images only appear, as in No. 3; then to pass by each other, when four images are again seen. By a yet greater convergence I am able to cause the image marked 3, in No. 4, to lap upon the image marked 1; and the image marked 2, to lap upon the image marked 4, as follows:  . From which I infer, that by a still greater convergence, these images can be made not only to coalesce—when two images only would be seen—but to pass by each other, when four images would again appear in the following position: , and so on, till the images marked 1 and 4 coalesced and passed by each other, and even till all the four images had changed their relative position and assumed the following  ,—that is, the reverse of the order in No. 2.

I tried the experiment with three, and with four pieces of paper, and found the same principle to prevail as with two, the only modifications being those which would arise from the greater number of images. With five pieces of paper I was unable to preserve the images distinct, or to bring them all in view, but

very easily discovered that the same law was followed in the order of their appearance. The appearances from three pieces of paper were the following—commencing with "natural single vision," and numbered in the order of the degree of convergence. The images that are doubled are placed nearer each other than the others; No. 1. □ □ □—No. 2. □ □ □ □—No. 3. □ □ □ □ □, or □ □ □ □ □ according as the *attention*, or the eye, is turned more particularly to the right or left. No. 4. $\overset{1\ 2\ 3\ 4\ 5\ 6}{\square\,\square\ \square\,\square\ \square\,\square}$— No. 5. $\overset{1\ 2\ 3,4\ 5\ 6}{\square\,\square\ \square\ \square\,\square}$—where the images 3 and 4, separate in No. 4, are here made to coalesce. No. 6. $\overset{1\ 2\ 3,4\ 5,6}{\square\,\square\ \square\ \square}$, or $\overset{1,2\ 3,4\ 5\ 6}{\square\ \square\ \square\,\square}$, according as the attention is given to the right or left. No. 7. $\overset{1,2\ 3,4\ 5,6}{\square\ \square\ \square}$—where we have three images again. No. 8. $\overset{1,2\ 4\ 3\ 5,6}{\square\ \square\,\square\ \square}$ —where the images 3 and 4 have been made to pass each other while the other remains united. No. 9. $\overset{1,2\ 4\ 3\ 6\ 5}{\square\ \square\,\square\ \square\,\square}$, or $\overset{2\ 1\ 4\ 3\ 5,6}{\square\,\square\ \square\,\square\ \square}$—according as the attention is given to the right or left. No. 10. $\overset{2\ 1\ 4\ 3\ 6\ 5}{\square\,\square\ \square\,\square\ \square\,\square}$—where each of the images of the several pairs have been made to pass its fellow, and six images again appear. I am nearly able to lap the images marked 1 and 4, and those marked 3 and 6, as in the case with two pieces of paper, as follows: No. 11. $\overset{2\ 1,4\ 3,6\ 5}{\square\ \square\!\square\,\square\!\square\ \square}$. By continuing to increase the degree of convergence these images can be made to coalesce, so that there will again be only three images, thus: $\overset{2,4\ 1,6\ 3,5}{\square\ \square\ \square}$, and even to assume a position reverse to that in No. 4, thus: $\overset{6\ 5\ 4\ 3\ 2\ 1}{\square\,\square\,\square\,\square\,\square\,\square}$, as was said in the instance of two pieces of paper.

Under the head of "some of the phenomena of the illusive image," Dr. Locke observes,—"as the head is inclined to the right or left, the superimposed pictures slide out from each other, the one ascending and the other descending to the extent of the inclination." I found, when using two pieces, with a convergence of the optical axes sufficient to produce three images, that if the head be then inclined to the right shoulder at an angle of 45°, there would then appear four images in the following position: . By permitting the convergence to diminish gradually, the images marked 1′ and 2′ would be seen to move along the dotted lines and finally coalesce with the images 1 and

2 at the moment there was no convergence. On the other hand, if the head be inclined to the left, at the same angle, the images would assume a similar position but would coalesce differently, as the convergence was diminished, as follows: . If the head, in either of these cases, be made to lie parallel to the shoulders, or so that the eyes will be vertical, the images will assume the following position: , where the images marked 1 and 4 are the illusive images when the head is inclined to the right, and those marked 2 and 3 the illusive when the head is inclined to the left. The position of these images is found to be the same as will be assumed, when the convergence of the optical axes is brought to bear upon two pieces of paper, placed the one above the other, in the following manner: .

Instead of the intermediate images in No. 2, in the experiment with two pieces of paper, being made to coalesce with one another, as seen in No. 3 of the same experiment, they can be made, while passing each other, to *turn out* to the right or left, as follows: , or where the images move in the direction of the lines with which they are connected.

In performing the third experiment of Dr. Locke, "of converging the optical axes upon two contiguous figures on the wall paper," and thereby obtain an image in front of the wall—called by him "illusive image"—I was not so successful. An "illusive image" is indeed seen, but it possesses so *much* of that character as not to permit of my treating of it. I find no difficulty, however, in superimposing pictures, or pieces of paper of different sizes.

The principle involved in all of these results seems to be embraced in the 5th inference of the first experiment of Dr. Locke, of seeing two images when the convergence of the optical axes is brought to bear upon one object, viz., "*that certain parts of the retina of one eye* CORRESPOND *to certain specific parts of the retina of the other eye in such a manner that when identical pictures fall on those corresponding parts single vision is the result.* Those corresponding parts lie inward in one eye and outward in the other, viz.: both to the right or both to the left. From each of those corresponding parts of the retina, it is probable that the fibres of the optic nerve proceed, and severally unite at the point of anatomical communication where the optic nerves cross, before entering the brain; hence the single impression or single image."

It appears that the eyes of an individual are not a *pair* in the sense of the word as applied to gloves—the one designed for the right and the other for the left hand, but two *alike*, performing the office of vision just as well if their places should be changed. This offers a perfectly satisfactory answer to the question—why we do not see objects double with two eyes.

ART. XXX.—*Observations on American Species of the Genus Potamogeton, L.;* by EDWARD TUCKERMAN, A.M.

(Continued from vol. vi, p. 224.)

THE following notes, as well as those already printed in this Journal, have been in every instance derived from examinations of living plants, enlarged by subsequent comparison of dried specimens. The terminology is that of Chamisso's Monography; and beside this, reference has been made constantly to the revision of the Swedish Potamogetons by Fries, in his *Novitiæ*, and to Koch's *Synopsis* of the German Flora. I may be permitted to add that I owe to Professor Nolte, of the University of Kiel, who has pursued for many years the study of these plants, which he has illustrated in his Novitiæ, and elsewhere,—and who first directed my attention to them, a large and invaluable set of the species of Schleswig and Holstein.

POTAMOGETON NATANS, (L.): caule simplici tereti; foliis omnibus longe petiolatis, natantibus coriaceis subcoriaceisve ovato-ellipticis basi sæpius cordatis apice obtusiusculis submucronatis oblongis ellipticisve multinervibus, petiolis concaviusculo-convexis; petiolis submersis inferioribus aphyllis acuminatis; stipulis elongatis lineari-linguiformibus acutis; pedunculis crassis subæqualibus foliis brevioribus; spicis cylindricis densifloris; fructibus recentibus oblique obovatiusculis, stylo brevi faciali apiculatis, dorso arcuato obtusiuscule carinatis, lateribus convexis in faciem acutiusculam declivibus. *P. natans, L. Suec.* 145, *e Fr. Chamiss. in Linnæa*, 2, 217, *t. vi, f.* 20. *Fr. Novit. Fl. Suec., p.* 28. *Koch. Syn., p.* 672. *A. Gray! Man. Bot., p.* 455, *a. Wood Bot., p.* 524, *e descr.*

HAB. In stagnant and in flowing water; common in New England. The description was taken from specimens growing in stagnant pools near Lake Champlain, at Burlington, Vt., which agree generally with specimens from other parts of New England, and from Western New York, (*Dr. Sartwell!*) FL. June and July. FR. August and September. Stems simple, terete, many arising from the creeping root. Leaves all on long footstalks; the lowest bladeless and acuminate; the others ascending toward

the surface of the water and floating, from membranaceous at length more or less chartaceous-coriaceous, not attenuate at base, broad- or ovate-elliptical, with very commonly a cordate base and an obtuse and more or less distinctly mucronate tip, many-nerved, often about 2½ inches long by nearly 1¾ wide; the footstalks slightly concave above. Stipules elongated, acute. Peduncles nearly equal, shorter than the leaves. Nutlets rather large, obliquely a little obovate, the arched back obtusely carinate, (acute when dry,) the sides at length convex and sloping to the acutish face which is apiculate with the short style. Exocarp thick, thickened above. Putamen very thick, woody. Seed uncinate, or somewhat 'curvisculo-uncinate,' (Cham.) The exocarp being removed, the nutlets appear obscurely tricarinate from a sunken line on each side of the acutely-carinate back, and the sides are slightly impressed in the middle. As compared with the fruit of *P. natans* that of *P. amplifolius* is lunate, and the exocarp being removed still mucronate with the style, the sides are conspicuously impressed at the middle, and the back is rounded-carinate.

Potamogeton fluitans, (Roth): caule simplici tereti; foliis omnibus in petiolum attenuatis, submersis membranaceis plus minus petiolisque elongatis, multinervibus; natantibus coriaceis late lanceolatis ovalibusve, petiolis rotundatis lamina plerumque haud longioribus; stipulis elongato-linguiformibus bicarinatis acutis; pedunculis incrassatis; spicis cylindraceis densifloris. *Roth. Germ. e Nolt.! Novit. Holsat., p.* 16. *Chamiss. l. c., p.* 219–221. *Fr. Novit., p.* 29. *Koch. Syn., p.* 673. *P. natans, β. Chamiss. Adn., p.* 4, *& Auct. pl. A. Gr. Man. Bot., p.* 455.

Hab. Erie Canal near Seneca Lake, and in stagnant brooks emptying into the same lake, New York. Stem simple, terete. Leaves all attenuate into the roundish (above scarcely flattened) foot stalks, and acute both ways; the submersed ones lanceolate, more or less elongated, membranaceous, many-nerved closely netted-veined, on rather elongated footstalks; the floating ones coriaceous, broad-lanceolate or oval, acute, many-nerved and about 6 nerves prominent beneath, very closely netted-veined, from about 2½ to 4½ inches long, by 1 to 1½ in. wide, on footstalks mostly shorter and never longer than the blade. Stipules much elongated, strongly 2-ribbed, acute. Peduncles thickened, shorter than the leaves. 'Nutlets compressed, acutely carinate.' My specimens are without fruit, but agree in every other respect with those of Prof. Nolte, from Holstein, which are cited by Chamisso, Fries, and Koch. The species is considered distinct by these authors, and without regarding the fruit, the American plants appear to differ from *P. natans* equally with the European, in the attenuate base of their leaves, in the submersed leaves being always present, in their more rounded petioles, and their bicarinate stipules.

Potamogeton amplifolius, Tuckerm. This species, indicated in the previous number of this Journal already referred to, occurs very abundantly in Lake George, and in Seneca Lake, New York, in a wholly submersed state, growing in deep water, when its length, its large leaves, and its finally much elongated peduncles make it perhaps more striking than any other of our Potamogetons. Between this, which is probably to be considered the more perfect, if not the typical state, and that which I have found most common in New England, and described as above, in which the habit of the plant is altered by the emergence of its apex, and the consequent production of floating coriaceous leaves, there is another, in some respects intermediate form, proper apparently to shallow pools, which demands separate notice. The stem in this last is much abbreviated, and the approximated leaves, either all submembranaceous, or the upper ones coriaceous, are shorter, firmer, and more oval. I gathered my specimens near the Niagara river, on the Canada side, and a similar plant, sent from Kentucky by *Dr. Short*, is in Prof. Torrey's herbarium. It is probable that the three states thus indicated,—that peculiar to deep water, and wholly submersed (*forma homophylla*, Fries.), that with floating leaves differing from the submersed ones, in shallower water (*forma heterophylla*, Fr.), and the third occurring where there is least water, and passing into abnormal forms (*forma amphibia*, Fr.) are all the prominent ones of the present, as of many other species. The differences between plants of still deep water (*status lacustris*, Fr.) and those of flowing water (*status fluviatilis*, Fr.) though often striking as respects the leaves, are much more easily appreciated than the above. The fruit of this species is more or less distinctly lunate, the sides somewhat flattened, and the exocarp being removed the style is persistent, and the back rounded-carinate; a sunken line on each side more or less defining the subobsolete, obtuse lateral keels. The *heterophylline* state extends westward to Fort Gratiot, (Dr. Pitcher, *Herb. Torr.!*)

Potamogeton rufescens, (Schrad.): caule simplici tereti; foliis submersis membranaceis, superioribus nunc subpetiolatis reliquis sessilibus, validiusculis anguste lanceolatis basi apiceque attenuatis acutiusculis multinervibus nervis 3–5 conspicuis; natantibus subcoriaceis planis nervis circ. 7 subtus prominulis plus minus obovato-lanceolatis apice acutiusculis, in petiolum compressum concavo-convexum lamina breviorem attenuatis; stipulis hyalinis elongatis levissime nervosis acutis; pedunculis subæqualibus plano-convexis elongatis; spicis cylindricis rufescentibus; fructibus recentibus lenticulari-compressis obovatis, stylo subapicali mucronatis, dorso acutiuscule subalato-carinato, lateribus convexis utrinque declivibus, facie acutiuscula. *P. rufescens, Schrad. in Chamiss. Adn., p. 5*, e Cham. *Chamiss. in Linnæa,*

2, *p.* 210. *Fries. Novit., p.* 30. *Koch. Syn., p.* 674. *Kth. Enum.*, 3, 129. *A. Gr. Man. Bot., p.* 455. *P. oppositifolius, DC.* e Cham. *Nolt.! Nov. Holsat., p.* 17.

Hab. Stagnant and flowing waters. In the two streams at the foot of Lake George, New York. Also in the rapids of the Niagara near Bath Island, and according to Chamisso in the river Mistassin. Stem terete, (often, as well as the peduncles and petioles somewhat muricate with regular, prickle-like excrescences,) mostly simple, but in luxuriant states often branching above, the whole plant and especially the upper portion becoming more or less purplish-rufescent when dry, 1½ to 3 feet long. Submersed leaves membranaceous, slightly rigid, rather narrowly lanceolate, tapering to the base, and more or less so above to the acutish tip; the upper ones often petiolate, the rest sessile; many-nerved, from 3 to 5 of the nerves more conspicuous; rather closely netted-veined; 2–4 inches long by 3–7 lines wide. Floating leaves (often wanting) subcoriaceous, flat, oblong- or obovate-lanceolate, acute above, with about 7 prominent nerves on the under side, 2–4 inches long by 3–9 lines wide, tapering at the base to the compressed, concave-convex petioles, which are shorter than the blade. Stipules rather long, delicate, acute (finely ribbed when dry.) Peduncles scarcely thickened in the smaller plants from Lake George, but evidently so in those from the Niagara, elongated, plano-convex, 2–5 inches long. Spikes cylindrical, many- but not continuously nor densely-flowered, 1–2 inches long. Nutlets lenticular-compressed, mucronate with the short style, the sides convex at the middle and sloping each way, the back rather obtusely subalate-carinate, (acute when dry, and the lateral keels often evident,) the face commonly also carinate, and acutish. Exocarp thick, produced at the back, and forming the wing. Putamen rather thick and hard. Seed convolute-uncinate. The exocarp being removed, the back appears acutish, with a sunken line on each side. The American plants above cited agree with the European in every important character. The Niagara specimens are often branched above, but this is doubtless owing to their luxuriant growth, to which I also attribute the thickening of their peduncles. The peculiar murication of the stem, &c., also occurring in the Niagara specimens, I have observed in another species not yet described in this place.

Potamogeton lonchites, Tuckerm. in Sill. Journ., l. c. The *homophylline* or wholly submersed form is common in company with the *heterophylline*, and with that, is abundant in the Connecticut, in Massachusetts, where I have gathered specimens with leaves a foot long. These forms, always characterized by their slender habit, long and narrow, very loosely veined, membranaceous submersed leaves, rather rounded petioles, and smallish fruit, appear to extend westward to the Kentucky river, (Dr. Short. *Herb.*

Torr. !) I gathered in the Niagara rapids, near Bath island, and have since received from Penn Yan, New York, (*Dr. Sartwell,*) a remarkable state of this species probably to be referred to the *amphibious* form of Fries. In this the stem is simple (compare Fries's observations, *Novit.*, p. 39, on an analogous state of *P. gramineus* '*primo obtutu cum P. oblongo conjungenda*'), and the broad, oblong, or oval leaves are either all coriaceous and floating, or only the lowest submembranaceous; the length of the flattened petioles being often almost the only index to the real affinity of the plant, the whole habit of which accords, often strikingly, with that of *P. fluitans;* but its strongly marked fruit at once refers it to the present species. The published description of the fruit of this species was from immature nutlets. The following is taken from perfectly ripe ones observed in the Niagara plants, in those of the Connecticut above mentioned, and (in the dry state) in the admirable specimens of *Dr. Sartwell.* Fr. recentes oblique obovati lunati, compressiusculi, subtricarinati, stylo apicali apiculati, dorso arcuato acute præcipue superne subalato-carinato sinuato-dentati, carinis lateralibus subobsoletis, facie recta obtusa. The lateral keels are conspicuous when dry. Exocarp thin. Putamen thick, and thickened above. Seed *uncinate*, a little curved. The exocarp being removed, the back appears acutely carinate, and a little alate, especially above; with a sunken line one each side defining the rather obscure, obtuse, lateral keels; the sides a little impressed at the middle. At the conclusion of the Monography of Chamisso a large number of *Potamogetons*, exotic as respects Europe, of which the specimens were insufficient to permit of their satisfactory determination, are thrown together as provisional varieties of *P. fluitans;*—the learned author, leaving it, as he says, to others, to distinguish and designate these plants, so far as might turn out to be necessary, as species. Two of these (pp. 226, 227) have been already referred, in the previous number of this Journal, already cited, to *P. Claytonii;* and the only remaining North American *Potamogeton* noticed, (*P. fluitans*, e. *Americani*, *Americanus*, thus provisionally designated, p. 226,) is most probably an *amphibious* state, like one above described from Niagara, of *P. lonchites;* and if so, as the species just named is typically, judging from its most perfect conditions, a branched *Potamogeton*, of a distinct tribe from *P. fluitans*, there can be no doubt of the necessity of separating Chamisso's plant from the latter. It is however so near to the *P. nodosus* of Poiret, Enc. Suppl. iv, p. 535 (the *P. fluitans*, c. *canarienses*, *nodosus*, Chamiss. l. c., p. 222), as the German author himself remarks, that I cannot but consider it possible that the several American plants, brought together, in these papers, under the name of *P. lonchites*, together with Chamisso's specimens above quoted, may finally prove to be identical with the older

species of the Canary Islands. What relation to this the '*P. occidentalis*, Sieber,' of the West Indies, (*P. fluitans*, d. *occidentalis Antillanus*, Chamiss. l. c., p. 224,) may have, must be left to future investigation.

Potamogeton gramineus, (L.): caule gracili tereti ramosissimo, ramis ramosis dense foliosis; foliis submersis membranaceis lineari-lanceolatis breviuscule acuminatis basi attenuatis nervis 3–6 obscuris, caulinis latioribus, superioribus petiolatis, rameis minoribus reliquisque sessilibus, petiolis supra planis; natantibus minusculis chartaceo-coriaceis submembranaceisve lanceolatis ellipticis ovato-ellipticis ovatisve, petiolis longiusculis compressiusculis plano-convexis; stipulis gracilibus lineari-linguiformibus margine scariosis acutiusculis; pedunculis leviter incrassatis spicis cylindraceis longioribus; fructibus recentibus minusculis oblique subrotundo-obovatis lunatis compressiusculis, stylo brevi subapicali apiculatis, tricarinatis, carinis superne productis acutiusculis, lateribus convexis, facie superne producta obtusa. *P. gramineus, L. Suec.* 2. *n.* 151, *e Fr. Novit., p.* 35. *Wahl. Lapp., p.* 52. *Koch. Syn., p.* 674. *Kth. Enum.* 3, *p.* 130. *P. heterophyllus, Schreb. Spicil. Fl. Lips., p.* 21, e Chamis. *Nolt.! Novit. Fl. Holsat., p.* 18. *A. Gr. Man. Bot., p.* 455, (excl. *P. Claytonii.*) *P. Proteus γ. heterophyllus, Chamiss. in Linnæa*, 2, *p.* 202, *t. v, f.* 16. *c. f. g. h.*

Hab. Still and flowing waters; very common in the ponds and streams of New England; and the lakes of Western New York; and extending westward to Lake Superior, (*Prof. Agassiz!*) Stem slender, terete, in the forms of shallower water much branched, the branches in these forms being also approximated, and all as well as the stem, often terminated by floating leaves; in those of deep water (as of Lake George, and Seneca Lake, N. Y.) less branched and not at all at the upper extremity, the internodes also much elongated. Submersed branches always ramulose and thickly clothed with leaves, smaller and narrower than those of the stem. Submersed leaves membranaceous, pellucid, linear-lanceolate, a little acuminate above, tapering at the base, obscurely 3–6 nerved, obsoletely netted-veined, those of the stem larger and the upper ones more or less petiolate, 2–3 inches long, 3 by 5 lines wide, the petioles flat above; those of the branches smaller, more linear, ¾ in. to 1½ inches long by 1–3 lines wide. Floating leaves chartaceous, or often submembranaceous (or wanting), always rather delicate, from lanceolate varying to ovate and obovate, but very commonly elliptical or ovate-elliptical, with a more or less obtuse base; those of the deep water forms smaller, and commonly submembranaceous; with about 6–8 inconspicuous, impressed nerves on the under side, on compressed, plano-convex, scarcely elongated petioles Stipules of the branches very small, but those of the stem larger,

rather slender, short, more or less scarious at the margins, acutish. Peduncles a little thickened, rather more than twice as long as the spikes, but elongated in the deep water forms, and occurring 10 inches and more in length. Spikes slender, densely flowered. Nutlets small, somewhat rounded, obliquely obovate, lunate, 3-carinate, the keels a little prominent and acutish above, the sides convex, the face produced above and apiculate with the very short style. Exocarp rather thin. Putamen thickish, but not hard. Seed curved-uncinate. The exocarp being removed, the sides appear rather suddenly hollowed, at the middle, toward the face. Agrees with the European specimens in habit, in the leaves, and the fruit. *P. lonchites* is at once distinguishable from the present species by its large size, and the different habit induced by its nearly simple branches; and its dentate-cristate fruit separates it from every described European species. The leaves of *P. gramineus* often approach a sublinear form, but the proper affinity of the species is with *P. nitens* and *P. lucens*, and not with the Graminifolii, or truly linear-leaved section.

Potamogeton compressus, (L.): caule alato-complanato ramosissimo; foliis omnibus submersis saturate viridibus membranaceis linearibus versus apicem sensim vix attenuatis apice breviter acuminatis cuspidatis, basi haud attenuatis sessilibus, 3–5-nervibus, infimis brevioribus multinervibus; stipulis linguiformibus pellucidis acuminatis demum laceris; pedunculis compressis spicis cylindricis continuis haud duplo longioribus; fructibus recentibus obovato-oblongis, stylo apicali leviter recurvo-rostratis, dorso latiore acute carinato sinuato-dentato, carinis lateralibus obsoletis, facie obtusa. *P. compressus*, *L. Suec. n.* 203, *e Fr. Novit., p.* 45. *Torr.! Fl. U. S., p.* 198. *Koch. Syn., p.* 676. *Beck.! Bot., p.* 386. *A. Gr.! Man. Bot., p.* 456. *Wood Bot., p.* 526. *P. zosteræfolius*, *Schum. Enum. pl. Sael.* e Cham. *Nolt.! Novit. Fl. Holsat., p.* 19. *Chamiss. in Linnæa*, 2, *p.* 182. *t. iv. f.* 10.

Hab. Ponds and slow streams, common in New England, and westward. In the western part of New York it attains to a much larger size than with us, and often not a little resembles Schollera, with which I found it growing. Stem much compressed, and winged, very much and long branched, 1–2½ feet long. Leaves dark green, all submersed and membranaceous, linear, above sensibly a little attenuate toward the abruptly and shortly acuminate and cuspidate tip, at the base not attenuate, sessile; 3–5-nerved; sparsely and obsoletely here and there veined; 3½ to 8 inches long by 1¼ to 2 lines wide; the lowest ones shorter, broad-linear, obtusish and submucronate, many-nerved. Stipules large, delicate, pellucid, green with whitish margins, finely many-nerved and the two lateral nerves prominent, acuminate and at length lacerate. Peduncles compressed, not reflexed in fruit, com-

monly not twice as long as the cylindrical, rather few-flowered spike. Nutlets large, oblong, a little rostrate with the apical, slightly recurved style; the broad back acutely carinate, and sinuate-dentate, with one prominent tooth near the base; the lateral keels obsolete, sides rather convex, and impressed at the middle, (but not so, according to Chamisso, in the entirely mature fruit;) the face obtusely carinate. Exocarp thick. Putamen thickish, not hard. Seed uncinate-convolute. Chamisso does not describe the fruit of *P. compressus* as minutely, in some respects, as in other species, and his figure corresponds less nearly with the nutlets of our plants, than the general features of his description. The dentation of the back is not mentioned in any description that I have seen of the present species, and if, as appears to me nearly certain, the American plants above described are inseparable, specifically, from the European, this character, a conspicuous one in several American species, must be reckoned of secondary importance.

Potamogeton Niagarensis, (Sp. nov.): caule complanato ancipiti rigidiusculo ramoso; foliis omnibus submersis membranaceis firmioribus linearibus versus apicem sensim attenuatis apice acutis mucronulatis, basi attenuatis subpetiolatis, sub-trinervibus; stipulis lato-linearibus membranaceis acutiusculis demum laceris; pedunculis compressis clavatis brevissimis; spicis paucifloris capitatis; fructibus recentibus lenticulari-compressis oblique subrotundo-obovatis stylo apicali mucronatis, dorso deorsum curvato acute lato-alato-carinato, carina superne subgibboso-producta, sinuato-dentata, lateribus convexiusculis in faciem subalato-carinatam declivibus.

Hab. Niagara falls, near the brink of the Hog-back, growing plentifully with Udora; and elsewhere in the river. Fr. August—September. Stem much compressed and sharply two-angled, firm, much branched, 1–2 feet long. Leaves all submersed, membranaceous, rather firm, dark green, linear, above sensibly tapering to the suddenly acute and mucronulate tip; at the base much attenuate, subpetiolate; 3–5-nerved, the exterior lateral nerves commonly obscure or obsolete; the space next the midrib on each side more or less evidently reticulate-cellulose; very obsoletely and sparsely veined; 1½–3½ inches long by half a line to rather more than a line wide. Stipules broad-linear, membranaceous, finely nerved, acutish at the tip, which is at length lacerate or even setose; the longest 6–8 lines long. Peduncles not numerous, axillary, erect, very short, compressed, clavate, 2–4 lines long. Spikes few- (8–12) flowered, capitate, subglobose. Nutlets somewhat rounded, lentiform-compressed, the back curved downward below the apparent base, broadly alate-carinate, sinuate-dentate, a little hunched above, the sides convex and sloping to the alate face which is produced-acute at the

middle, the style apical. Exocarp thin, produced at the back and forming the wing, and less so, also, at the face. Putamen thickish. Seed convolute-uncinate. Intermediate in size between *P. compressus* and *P. pusillus* α, major, but differing in its characters from all our described species of this section.

Potamogeton pusillus, (L.): caule subcompresso ramoso; foliis omnibus submersis membranaceis pallide vel demum fuscescenti-viridibus linearibus apicem versus levissime basique brevissime attenuatis sessilibus, basi plus minus conspicue bi-lanadulosis, 3–5-nervibus, subobsolete venosis; stipulis linguiformibus pellucidis acutiusculis; pedunculis longiusculis subcompressis spicis subinterruptis vel confertis capituliformibus longioribus; fructibus recentibus oblique ellipticis, stylo subapicali brevissime rostratis, subtricarinatis, carina dorsali rotundato-obtusa deorsum curvatiuscula, lateralibus obsoletis. lateribus convexis, facie obtusa. *P. pusillus, L. Suec., n.* 153. *Chamiss. in Linnæa*, 2, *p.* 170, *t. iv, f.* 5. *Fries Novit., p.* 48. *Koch. Syn., p.* 677. *Kth. Enum.*, 3, *p.* 136. (excl. δ.) *Torr.! Fl. N. Y. A. Gr. Man. Bot., p.* 457.

α *major*, (Fries.): caule compresso minus ramoso; foliis latioribus obtusiusculis submucronatis sæpius 5-nervibus venosis; spicis plus minus cylindricis interruptis. *P. pusillus*, α, *Chamis. l. c. Fries l. c. Koch. l. c. Kth. l. c. P. compressus, E. Bot., t.* 418, e. Fr. *Mert. & Koch. Fl. Germ.* 1, *p.* 856, e. Koch, non L.

β. *vulgaris*, (Fries.): caule filiformi e tereti-subcompresso ramosissimo; foliis angustioribus acutiusculis 3-nervibus subaveniis; spicis sæpius abbreviatis floribusque capitatim confertis. *P. pusillus*, γ, *Chamiss. l. c. P. pusillus*, β, *Fries l. c. Koch l. c. Kth. l. c. P. pusillus, Auctt.*

γ. *tenuissimus*, (Mert. & Koch.): caule capillaceo e tereti-subcompresso ramosissimo; foliis angustissimis acutis cuspidatisque, sub-3-nervibus nervis lateralibus obsoletis, aveniis; spicis paucifloris. *P. pusillus*, β, *tenuissimus, M. & K. Germ.* 1, *p.* 856. *P. pusillus*, δ, *Chamiss. l. c. P. pusillus*, γ. *Fries. l. c. Kth. l. c.*

Hab. Still and flowing waters:—α in ponds and lakes, rather conspicuous; Cambridge; Lake Champlain; Seneca Lake, New York; and westward to Wisconsin (Mr. Lapham; *hb. Sartwell!*) —β in ponds, stagnant parts of rivers, and in ditches, Cambridge; Newton; and fine in Tewksbury pond.—γ Penn Yan, New York, (*Dr. Sartwell!*) I have seen but one specimen of γ, but it agrees very well with the character of the European variety, which differs from β principally in its very slender stem, and much narrowed leaves. The stem of this species is commonly more or less distinctly compressed, but in β and γ it is often nearly or quite terete; much branched, especially in β and γ; 1–2 feet long.

Leaves all membranaceous, pale green, in β and γ often fuscescent, linear, sensibly a little tapering upwards, and very shortly so at the base, which is more or less distinctly biglandulose, sessile;—in α broader, obtusish, submucronate, oftener 5-nerved, with here and there a few scattered, more or less conspicuous veins, which are most numerous in the highest, 1–2 inches long by ¼ of a line wide to a line in width;—in β narrower, more or less acute or acuminate and often cuspidate, 3-nerved, the lateral nerves commonly inconspicuous, the space next the midrib on each side more or less widely reticulate-cellulose, nearly veinless, 1¼–2 inches long by ¼ to ⅜ of a line wide;—in γ very narrow, acute or cuspidate above, the lateral nerves subobsolete, veinless, shorter than in the other varieties. Stipules large for the plants, delicate, pellucid, acute, at length lacerate. Peduncles subcompressed, or nearly terete, a little thickened near the spike, half an inch to 1½ inches long. Spikes more or less cylindrical and whorled, interrupted, few-flowered, about half an inch long; or, in β and γ oftener crowded-capituliform. Nutlets obliquely elliptical, subtricarinate, a little rostrate with the short style, the back rounded-carinate slightly curved downward below the apparent base, a sunken line on each side indicating the lateral keels, the sides convex and gently sloping to the obtusish face. Exocarp thin. Putamen thick, not hard. Seed convolute-uncinate. This species is probably rather common in the Northern States. The American plants here referred to α, and β, agree generally with my European specimens, and, as well as γ, are always recognizable by the rounded-carinate fruit. The variety α closely resembles *P. obtusifolius*, an European species not yet observed in this country, but is distinguished from it by its fruit, and its 5-nerved leaves.

Potamogeton pauciflorus, (Pursh): caule compresso ramosissimo; foliis omnibus submersis membranaceis saturate viridibus anguste linearibus versus apicem sensim levissime basique brevissime attenuatis sessilibus, apice acutis, 3-nervibus, nervis lateralibus plus minus obsoletis, subvenosis; stipulis linguiformibus membranaceis teneris acutis; pedunculis brevibus compressis sub spica incrassatis spicis paucifloris capitatis subglobosis floriferis plus minus reversis, subduplo longioribus; fructibus recentibus subcompressis, dorso vel acute carinato sinuato-dentato oblique ellipticis vel lato-alato dentato subrotundo-obovatis, mucronato-rostratis, carinis lateralibus obsoletis, lateribus convexiusculis in faciem vel acutam vel carinatam declivibus. *P. pauciflorus, Pursh Fl.* e Chamiss. *Barton Comp. Fl. Phil.* 1, *p.* 97. *Ell. Sk.* 1, *p.* 222. *Bigel. Bost. edit.* 2, *p.* 63. *Torr.! Fl. U. S., p.* 198. *Chamiss. in Linnæa.* 2, *p.* 176, *t. iv, p.* 7. *Kth. Enum.* 3, *p.* 136. *Beck Bot., p.* 386. *A. Gr.! Man. Bot., p.* 457. *Wood Bot. p.* 526. *P. gramineus, Michx. Fl.* 1,

p. 102, e Chamiss. *P. exstipulatus*, (*Muhl.*) *Herb. Willd.* part. e Chamiss.

Hab. Ponds and slow streams; Cambridge; and common in New England; and from the eastern part of New York, (*Prof. Torrey!*) to western New York, (*Prof. Gray!*) westward to Kentucky (Dr. Short. *Hb. Torr.!*) and California, (*Chamisso,*) southward to South Carolina, (*Michaux,*) and Louisiana, (Dr. Hale. *Hb. Torr.!*) Chamisso found it also in the Sandwich Islands. Stem compressed, branched, at first mostly below, but at length very much so above, 6 inches to about 1½ feet long. Leaves membranaceous, dark-green, narrow-linear, above sensibly a little attenuate to the acute and often somewhat mucronate tip, shortly tapering at base and sessile; mostly 3-nerved, but the lateral nerves more or less obsolete and sometimes entirely so; with commonly but a few scattered veins, but these sometimes frequent and conspicuous, especially in the highest leaves; the space next the midrib on each side more or less widely reticulate-cellulose; somewhat obsoletely glandulose at base; 1–2 inches long by ¼ to ½, or, especially in the western plants, ¾ of a line wide. Stipules delicate, short, acute. Peduncles short, compressed, thickened immediately below the few-flowered, capitate, sub-globose spike, which is more or less reversed in flower but becomes erectish in fruit. Nutlets compressed, subtricarinate; the back a little curved downward below the apparent base, and sinuate-dentate; either acutely subalate-carinate, when the whole outline is obliquely elliptical, or semicircular and broad-alate, when the outline is rounded-obovate; mucronate-rostrate with the short style; the lateral keels obsolete; the sides very slightly convex, and until quite mature, punctiform-impressed at the middle; the face acutish, or in the broad-winged fruits, carinate. Exocarp rather thin; produced at the back and forming the wing. Putamen thick, not hard. Seed convolute-uncinate. The exocarp being removed the back appears more or less *acutely* carinate. The stress of difference between this species and *P. pusillus*, β, is in the fruit; though the darker color of its more constantly acute, and more venose leaves, its shorter stipules, and its short-peduncled, few-flowered, subglobose spikes, will also furnish perhaps quite reliable differences. And I have thus far found the commonly conspicuous glands at the base of the leaves of *P. pusillus*, a safe index to that species; these glands in the present, so far as my observation has gone, being either nearly or quite obsolete; as Kunth, who inserts '*eglandulosis?*' into his character, appears to have found them. The discrepancy between the descriptions of the fruit given by Chamisso and by Kunth, seems to be reconciled by a consideration of the varying width of the wing, this difference serving to alter materially the whole outline of the nutlets. In the very narrowly winged fruits,

the outline is not dissimilar from that of the nutlets of *P. pusillus*, but the sides are flattish, and the back is acute. Pursh omits, in his *Flora*, the customary mark of having seen this species living, repeating there merely the character and habitat given in Michaux's *Flora* to the *P. gramineus* of that work; and there is no specimen of it in his herbarium. Michaux's plant is therefore the *fons speciei*, and Chamisso, who had seen a single nutlet from the specimen preserved at Paris, says, (l. c., p. 178,) that though this differed a little, in its larger dimensions, from the fruit of his specimens of *P. pauciflorus* from the Sandwich Islands, both might well belong to the same species.

Potamogeton trichoides. (Cham. and Schlecht.): caule teretiusculo ramosissimo; foliis omnibus submersis membranaceis longiusculis concavo-convexis setaceo-linearibus versus apicem sensim levissime basique brevissime attenuatis sessilibus, apice acutissimis, uninerviis, aveniis, reticulato-cellulosis; stipulis linguiformibus amplectentibus acutis; pedunculis elongatis; spicis subinterruptis, vel sæpius confertis abbreviatis; fructibus recentibus oblique lunato-ovatis, dorso latiori tricarinatis, carina media semicirculari obtusiuscule subalato-carinata, lateralibus discretis obtusiusculis, lateribus planiusculis medio impressis, facie obtusa basin versus unidentata, stylo faciali brevissimo. *P. trichoides, Cham. and Schlecht. in Linnæa*, 2, *p.* 175, *t. iv, f.* 6. *Koch. Syn., p.* 677. *A. Gr.! Man. Bot., p.* 457. *P. pusillus, β. e part. Mert. & Koch.* 1, *p.* 857, e Chamiss. *P. pusillus, var. Oakes in sched. olim!*

Hab. Ponds. Near the Notch of the White Mountains, in the Trout-pond, abundant, and first detected there by the late Mr. Oakes, and Dr. Robbins of Uxbridge. Also in Long pond, Tewksbury. Root creeping, branched, geniculate, or the stem itself prostrate and performing the function of a root. Stem slender, terete; much- and spread-branched below, rather distantly branched above; the branches repeatedly ramulose; 12–18 inches long. Leaves rather long, delicate, pale-green; a little concave above, but appearing roundish in a cross-section; setaceous-linear, slightly and shortly tapering at base, and sensibly so above to the very acute tip; one-nerved; veinless; reticulate-cellulose; those of the stem about 2 inches long by $\frac{1}{8}$ to $\frac{1}{4}$ of a line wide, but those of the branches much smaller. Stipules rather firm, green, 3–4 lines long, largest at the lower part of the stem. The elongated, commonly simple apex of the stem serving as peduncle, and a little thickened immediately below the spike; 3–6, or more inches long. Spikes a little elongated and interrupted, but very commonly abbreviated and somewhat capitate, few-flowered. Nutlets obliquely lunate-ovate, a little compressed, tricarinate, the middle keel semicircular, narrowly winged, obtusish, sometimes a little sinuate; the lateral ones distinct, (and also sometimes sin-

uate when dry,) the sides flattish, and impressed at the middle; the face obtuse, one-toothed near the base; the style facial, and very short. Exocarp thick. Putamen thickish. Seed convolute-uncinate. I have seen no specimens of the European plant, but Chamisso's minute description, and his figure of the fruit, leave little or no doubt of the identity of ours with it. It is observable that the sinuate-dentation of the back of the nutlets, noticed in the American specimens of *P. compressus*, but not mentioned as occurring in any European species by Chamisso, is found also in the present.

Potamogeton hybridus, Michx. Since the publication of my notes upon this species, I have had an opportunity of examining the Potamogetons in the herbarium of Prof. Torrey, and have found specimens of *P. hybridus* from New Jersey, Virginia, Georgia, Alabama and Louisiana, none of which differ, so far as I have observed, materially, from the description above referred to, and all of which seem to me to confirm the characters of the fruit there detailed (as to its small size, its shape, and its distinct, sharp, often toothed lateral keels) which were relied upon as sustaining the remarkable difference of the submersed leaves, that appeared to distinguish this species from *P. Spirillus*, also there described. Chamisso considered *P. hybridus*, it would seem, to belong to the tribe *Natantes*, and he remarks that its leaves are to be regarded as bladeless petioles. But this will appear less probable on comparing it with *P. Spirillus*, (a plant unknown to the German author,) which explains the characters of the former species (somewhat obscure from its tenuity) and makes evident that both are to be referred to the section Graminifolii, and viewed, as perhaps, by the attachment of their leaves to the stipules, the connecting links between the tribes *Compressi* and *Pectinati*.

Potamogeton pectinatus, (L.): caule subtereti ramosissimo; foliis omnibus submersis membanaceis cum stipulis connatis basique vaginantibus lineari-setaceis versus apicem sensim attenuatis acutissimis, uninervibus, venosis; ligulis longiusculis scariosis demum lacero-setosis; pedunculis filiformibus æqualibus elongatis; spicis longiusculis interrupte verticillatis; fructibus recentibus oblique lunato-obovatis compressis, stylo faciali brevissimo apiculatis, dorso latiori rotundo-carinatis, carinis lateralibus obsoletis, lateribus planiusculis in faciem acutam declivibus. *P. pectinatus*, *L. Sp.* 183, e Koch. *Pursh! Fl.* 1, *p.* 121. *Torr.! Fl. U. S.*, *p.* 198. *Chamiss. in Linnæa*, 2, *p.* 164, *t. iv*, *f.* 2. *Fries Novit.*, *p.* 52. *Koch Syn. p.* 677. *Beck Bot.*, *p.* 386. *Kth. Enum.* 3, *p.* 137, (excl. *P. marino.*) *A. Gr.! Man. Bot.*, *p.* 457, (excl. *P. marino.*) *Wood Bot.*, *p.* 526, (excl. syn.) *P. marinus, Michx., Fl.* 1, *p.* 102, e descr.

Hab. In still and flowing water. In the Connecticut in Massachusetts; and thence to the Lakes of Western New York, (*Prof. Gray!*) and Niagara Falls. In the St. Lawrence, (*Michaux.*) In Lake Ontario, (*Pursh!*) In Lake Superior, (*Prof. Agassiz!*) Southward, New Jersey, (*Prof. Torrey!*) to Louisiana, (*Dr. Ingalls, Hb. Torr.!*) Stem a little compressed, plano-convex, much branched at the base, and also above, 1–2 feet long. Leaves commonly thickish, but also occurring more delicate, somewhat channelled above and convex below, more or less setaceous-linear, sensibly attenuate above and very acute, below connate with the stipules and clasping; one-nerved; with frequent, thickish veins disposed at right angles to the margin; 2–4 inches long, by $\frac{1}{4}$ to $\frac{3}{4}$ of a line wide. Ligules elongated lanceolate, whitish, at length lacerate-setose. Peduncles commonly much elongated, filiform, not thickened. Spikes rather long, interruptedly whorled, not many-flowered. Nutlets large, obliquely lunate-obovate, compressed, the broad back obtusely carinate, (rather acute when dry,) the lateral keels obsolete, but indicated by a slightly sunken line, the sides flattish, sloping to the somewhat acute face. Exocarp thick, wrinkled when dry. Putamen very thick, softish. Seed uncinate-curved. The exocarp being removed, the back appears rounded-carinate, (or in other fruits from the same station, acutely so, as in my French specimens,) the sunken lines on each side, which define the obsolete lateral keels, connivent below the apex of the nutlets, the sides a little convex, and very slightly, or not at all impressed at the middle, the style disappearing, and the whole outline becoming more elliptical. This description differs in some few particulars from Chamisso's, but our plants are probably inseparable, specifically, from the European. *P. marinus*, L., e Fr. and Koch, (*P. filiformis*, Nolte! and Chamiss.) a species nearly akin to this, but with rather shorter, longer-leaved stems, and small, ecarinate nuts, and peculiar to salt water, is perhaps to be detected here. I have seen a New Jersey specimen that appeared to resemble it, but it was without fruit.

Art. XXXI.—*On a New Table of the Pressure of Steam at various Temperatures;* by J. H. Alexander, Esq.

In a former Number of this Journal,* I gave the elements of a new theorem for calculating the tension of Vapor of Water at all temperatures; and presented at the same time an extensive tabulated comparison of the indications of this theorem with the results of the best experiments upon the pressure of steam. This comparison, extending between $-27°$ and $+435°$ of Fahrenheit's thermometer-scale, shewed among other things, that the pressures calculated by the theorem, agreed more closely and consistently with the mean of the observations than the experimental numbers did, themselves; and in so far, therefore, the formula was fully sustained.

A supplemental Memoir in a succeeding Number,† contained a discussion of the admitted uncertainties of divers experimental series (being also those, accepted as the best contrived and most reliable, hitherto) and of the consequent probable errors by the formula; the reasonable conclusion from all which, was that the mean probable error of this last is *less* than the actual contingent (or it may be, necessary) inaccuracies of the experiments; and therefore, that the reciprocal temperatures and pressures assigned by the theorem, were in fact more thoroughly and safely reliable than the quantities given in any single series of observations.

Accompanying this last memoir, was a short table whose argument is the pressure of Steam in Atmospheres; and it only remained, for completing the subject, to have a corresponding table whose argument should be the temperature in degrees of Fahrenheit. This I have prepared and now present. It extends from zero of Fahrenheit, for every five degrees, up to the melting point of ice; and progresses thence, from degree to degree, up to 365°, which may be considered as even beyond the limiting temperature for safe or judicious application. The pressures are given in inches of a mercurial column supposed at a constant temperature of 32° F.; but they can be converted into pounds avoirdupois per square inch very readily and with sufficient accuracy for the most of practical purposes, by halving the tabular numbers. The column of differences of elasticity for each degree, which had to be made up as one of the checks upon the arithmetical operation, has been retained and will be found frequently useful.

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* ii Ser., vol. vi, p. 210, seqq. † ii Ser., vol. vi, p. 317, seqq.

TABLE *of the Pressure of Steam in inches of Mercury at the temperature of melting ice from degree to degree of Fahrenheit's thermometer.*

Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.
0	0,040	0,002	85	1,39	0,04	145	7,20	0,17
.5	0,052	0,003	86	1,43	0,05	146	7,37	0,18
10	0,069	0,004	87	1,48	.	147	7.55	.
15	0,088	0,005	88	1,53	.	148	7,73	0,19
20	0,113	0,006	89	1,57	.	149	7.92	.
25	0,143	0,007	90	1,62	.	150	8.11	.
30	0,179	0,008	91	1,67	.	151	8.30	0,20
32	0,196	.	92	1,72	.	152	8.50	.
33	0,204	0,009	93	1,77	0,06	153	8,70	.
34	0,213	.	94	1,83	.	154	8,90	0,21
35	0,222	0,010	95	1,89	.	155	9,11	.
36	0,232	0,011	96	1,95	.	156	9,32	0.22
37	0,243	0,010	97	2,01	.	157	9.54	.
38	0,253	0,011	98	2,07	.	158	9.76	.
39	0,264	.	99	2,13	.	159	9,98	0,23
40	0.275	.	100	2,19	.	160	10,21	0,24
41	0.286	0,012	101	2,25	0,07	161	10.45	.
42	0,298	.	102	2,32	.	162	10,69	.
43	0.310	0,013	103	2,39	.	163	10.93	0,25
44	0.323	0,014	104	2,46	.	164	11,18	.
45	0.337	.	105	2,53	.	165	11.43	.
46	0.351	.	106	2.60	0,08	166	11 68	0,26
47	0.365	.	107	2,68	.	167	11,94	0,27
48	0,379	0,015	108	2,76	.	168	12.21	.
49	0,394	0.016	109	2,84	.	169	12.48	0,28
50	0.410	.	110	2.92	.	170	12.76	.
51	0,426	0,017	111	3,	.	171	13 04	.
52	0.443	.	112	3 08	0,09	172	13.32	0,29
53	0,460	0,018	113	3.17	.	173	13 61	0,30
54	0,478	.	114	3.26	.	174	13.91	.
55	0,496	0,019	115	3.35	.	175	14.21	0,31
56	0,515	.	116	3.44	.	176	14.52	.
57	0.534	0,020	117	3.53	0,10	177	14.83	0,32
58	0.554	0,021	118	3 63	.	178	15.15	.
59	0.575	.	119	3,73	.	179	15.47	0.33
60	0.596	0.022	120	3,83	.	180	15.80	0,34
61	0,618	0,023	121	3.93	0,11	181	16.14	.
62	8,641	.	122	4.04	.	182	16,48	0,35
63	0,664	0.024	123	4,15	.	183	16,83	.
64	0,688	0.025	124	4.26	.	184	17.18	0.36
65	0,713	0,026	125	4.37	0,12	185	17,54	0,37
66	0.739	.	126	4.48	.	186	17.91	.
67	0,765	0.027	127	4.60	.	187	18.28	0,38
68	0,792	0,028	128	4,72	.	188	18.66	.
69	0,820	0,029	129	4.84	0,13	189	19.04	0.39
70	0.849	.	130	4,97	.	190	19.43	0.40
71	0,878	0.030	131	5,10	.	191	19,83	0,41
72	0,908	0.031	132	5 23	.	192	20.24	.
73	0.939	0,033	133	5.36	0,14	193	20.65	0.42
74	0,972	.	134	5 50	.	194	21.07	0,43
75	1,005	0.034	135	5.64	.	195	21.50	.
76	1.039	0.035	136	5 78	0,15	196	21.93	0,44
77	1,074	.	137	5 93	.	197	22.37	0,45
78	1,109	0.037	138	6.08	.	198	22.82	.
79	1,146	0.038	139	6 23	.	199	23.27	0.46
80	1,184	0.039	140	6.38	0,16	200	23,73	0.47
81	1,223	0,040	141	6 54	.	201	24,20	0,48
82	1,263	.	142	6.70	.	202	24 68	0,49
83	1,303	0,043	143	6,86	0,17	203	25.17	.
84	1,346	0,043	144	7,03	.	204	25,66	0,50

TABLE—(Continued.)

Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Differ'ce for 1 degree.
205	26,16	0.51	265	75.60	1,24	325	186.24	2.61
206	26,67	0.52	266	76 84	1,25	326	188,85	2,64
207	27,19	0,53	267	78,09	1,27	327	191.49	2.66
208	27,72	0,54	268	79,36	1,28	328	194.15	2,69
209	28.26	0,55	269	80,64	1.30	329	196.84	2,73
210	28.80	.	270	81,94	1,33	330	199 57	2,76
211	29 35	0.56	271	83,27	1,34	331	202,33	2.80
212	29 91	0,57	272	84,61	1,35	332	205,13	2,84
213	30,48	0.58	273	85.96	1.36	333	207,97	2,87
214	31,06	0,59	274	87,32	1,39	334	210.84	2.90
215	31,65	0,60	275	88,71	1.41	335	213.74	2.94
216	32,25	0,61	276	90.12	1,43	336	216,68	2,97
217	32.86	.	277	91.55	1.45	337	219.65	3,
218	33,47	0,63	278	93,	1.47	338	222.65	3.03
219	34.10	.	279	94.47	1.50	339	225.68	3,07
220	34.73	0,65	280	95,97	1,51	340	228,75	3,10
221	35 38	.	281	97,48	1.52	341	231,85	3,13
222	36,03	0,67	282	99.	1,54	342	234,98	3.16
223	36,70	.	283	100,54	1,56	343	238,14	3.20
224	37.37	0,69	284	102,10	1,58	344	241.34	3,24
225	38.06	0,70	285	103,68	1.60	345	244.58	3.28
226	38.76	0,71	286	105,28	1.63	346	247.86	3,32
227	39.47	0,72	287	106,91	1.65	347	251,18	3.36
228	40,19	0,73	288	108,56	1,67	348	254,54	3.39
229	40,92	0,75	289	110,23	1,69	349	257.93	3.42
230	41.67	.	290	111.92	1,71	350	261,35	3.45
231	42,42	0,76	291	113.63	1,72	351	264 80	3.49
232	43.18	0.77	292	115.35	1,75	352	268,29	3.53
233	43 95	0,78	293	117.10	1,77	353	271,82	3,59
234	44,73	0.80	394	118,87	1,80	354	275,39	3.61
235	45.53	0.81	295	120,67	1.83	355	279.	3.66
236	46.34	0,82	296	122,50	1.85	356	282,66	3,71
237	47.16	0,83	297	124.35	1,87	357	286,37	3.75
238	47.99	0,85	298	126,22	1,89	358	290,12	3.79
239	48,84	0,86	299	128,11	1.91	359	293.91	3 83
240	49.70	0,87	300	130,02	1,93	360	297,74	3.87
241	50.57	0,88	301	131.95	1.96	361	301,61	3.91
242	51.45	0,89	302	133,91	1.99	362	305,52	3.95
243	52.34	0.91	303	135,90	2,01	363	309.47	3.99
244	53.25	0,92	304	137.91	2,03	364	313.46	4,04
245	54.17	0,94	305	139,94	2,06	365	317.50	
246	55.11	0,95	306	142,	2,09			
247	56,06	0.96	307	144,09	2,11			
248	57,02	0.97	308	146.20	2,13			
249	57.99	1,	309	148,33	2,16			
250	58.99	1,01	310	150.49	2.20			
251	60,	.	311	152.69	2,22			
252	61.01	1,03	312	154.91	2.24			
253	62.04	1,04	313	157,15	2,27			
254	63,08	1,07	314	159 42	2 30			
255	64,15	1,07	315	161.72	2,32			
256	65.22	1,09	316	164,04	2.34			
257	66,31	.	317	166.38	2,37			
258	67,41	1,10	318	168,75	2.40			
259	68.53	1,12	319	171.15	2,44			
260	69.67	1,14	320	173.59	2.48			
261	70,83	1,16	321	176 07	2.51			
262	71.99	.	322	178,58	2.53			
263	73.18	1,19	323	181.11	2.55			
264	74.37	1,23	324	183,66	2,58			

Formula.

p = pressure in inches.

t = temp. in deg. Fahr.

$$\therefore p = \left(\frac{t}{180} + \frac{990}{1695}\right)^6 ; \text{and}$$

$$t = 180\sqrt[6]{p} - 105°,13.$$

Also, if

p' = pressure in atmosphere of 29 915 inc. at 32° F.

t = temp. as before;

$$\therefore p' = \left(\frac{t}{317,13} + \frac{561.91}{1695}\right)^6$$

$$= \left(\frac{t}{317,13} + \frac{990}{2986,33}\right)^6$$

and

$$t = 317,13\sqrt[6]{p'} - 105°,13$$

ART. XXXII.—*On the Dispersion of Light;* by Lieut. E. B. HUNT, U. S. Corps of Engineers.

IT is my purpose in this paper,

I. To present a historical summary of the physical theories of chromatic dispersion.

II. To prove by reference to certain astronomical facts, that the *unequal velocities* of the *different colored rays*, forming the basis of the present most received theories, cannot exist to the extent required.

III. To present an outline of a new theory of chromatic and thermotic dispersion, essentially different in principle from any hitherto developed.

The technical importance of the unequal refrangibility of different colored rays and their consequent dispersion in the prismatic spectrum, is not less than its interest as a physical fact. To correct the chromatic observation and make a truly achromatic refracting telescope and microscope, was a triumph as splendid in results as difficult of attainment. The inability of the undulatory theory clearly to explain this fact, has long been the most serious objection to its unquestioned adoption, for it is charged not with a mere failure to explain, but a seeming proof that the fact cannot be. Nothing brings us more in contact with the physical character of light than the colored spectrum, and when we observe that all nature is presenting in ceaseless variety these same mingled hues, conversing with us almost solely through their ministry, they gather a new and living interest. As to Joseph, his "coat of many colors" was an ever-speaking token of that paternal regard and fondness, which followed him in all his wanderings; so to us does the "bow of promise" and the whole "shining robe of day," tell of a creating Father, and shadow forth his kind control.

I. Newton,* after experimentally proving that the different colored rays have different refractive indices for the same medium, and that these indices are independent of any mutual action of the colored rays on each other, being constant for each in any combination of rays or media, proceeded to show how, on the emission theory, this unequal refrangibility or chromatic dispersion could be explained by the received principles of mechanics. Ascribing the whole fact of refraction to the action of molecular forces at insensible intervals, he had only to conceive, in accordance with observation, some cause of difference between colors

* For the history, &c. of dispersion, see Lloyds Report to Brit. Association, 1834, p. 314. Whewell's History of the Inductive Sciences, vol. ii, p. 453. Herschel's Treatise on Light: Art. 564, 395, et seq.

in the time or intensity of this action. The facts required this cause to be something intrinsic in and peculiar to the several colored rays: peculiarities of media alone being wholly insufficient for an explanation. Newton ascribed dispersion to differences of size between the different colored luminous particles; the red being greatest and the violet smallest. To this a difference of identity or intensity of molecular action must be superadded, as no mere difference of volume, could, except in a resisting medium, produce a refractive difference. By M. de Courtivon and Mr. Melville, a difference of initial velocity was supposed: this, by subjecting the colored particles to molecular action for unequal times, would produce refractions varying as an inverse function of their velocities. Astronomical facts wholly disproved the hypothesis. The idea of heterogeneous particles, between which and the molecules of bodies, exist elective attractions, like chemical elective affinities, has been more widely entertained. Assuming the emission theory and excluding difference of chromatic velocities, we are forced to the admission of heterogeneous particles, either in the Newtonian mechanical sense or this elective affinity sense, which two nearly merge into each other. The emission theory hypothesis of heterogeneous particles, certainly represents the facts of dispersion.

But the theory itself, encumbered by the ideas of "fits," "sides" of rays, "rotating polarities," &c., has no strong claims on our admiration and acceptance. In truth, its explanatory powers, so far from embracing new optical discoveries as they have been developed, seem exhausted on the simple facts to which Newton applied them. Admitting the incorrectness of this theory, it is still singular that it should have served the purposes of explanation so well. We can scarcely avoid the belief, that in spite of its defects, it contains some vein of truth, and presents some fragmentary picture of nature's phases. If the views presented in this article be correct, the feature of molecular attraction on light, as the cause of its refraction, will be retained from Newton's theory, while that of emitted luminous particles is abandoned. This will effect a compromise between the emission and wave theories, by making the waves themselves, subject to molecular attraction, and that unequally according to their nature.

The fact of dispersion has been the chief stumbling block in the way of the wave theory. All attempts to explain it from this point of view, had by general consent, been unsatisfactory up to that commenced by Fresnel and completed by Cauchy. A failure to explain is compatible with sound theoretical bases, but the wave theory seemed to prove that dispersion could not exist: a conflict with fact which has been a great obstacle to its adoption. Mathematical investigations all indicated that the velocity of wave transmissions in the same medium of any density,

was wholly independent of the nature of the wave. But as refraction is ascribed to a change of velocity in passing through different media, and as each color in this change of media, entering along the same or parallel lines should pass through precisely the same succession of media, there seemed no possible reason why one ray should be more retarded or accelerated than another. Admitting Huyghens' explanation of refraction, there seemed to be no possibility of dispersion. Besides the analogy of sound, from which the wave theory is so largely drawn, is entirely averse to dispersion as due to unequal velocities: for all sounds are heard in the same original order at all distances, and have therefore equal velocities. Sir John Herschel, in alluding to this "great difficulty," says: "it must not be dissembled that it is impossible to look on it in any other light than as a most formidable objection to the undulatory doctrine." Yet the explanatory powers of this doctrine are such as to have exalted it into the list of physical generalizations.

Fresnel and Cauchy have brought forward and prosecuted the *hypothesis of finite intervals* to meet this difficulty. By supposing the interval between the ether particles, a sensible distance as compared with the lengths of luminous waves, a relation has been deduced between the length of wave and its velocity of transmission. The spectral rays having unequal wave lengths, should then have unequal velocities, retardations and deviations. This explanation turns wholly on a difference in the actual velocities of the different rays, and has no application if this difference does not exist. Assuming the correctness of the reasoning of these eminent mathematicians, its application to nature rests wholly on the question, whether the hypothesis of finite intervals be a fact; also, if the colored rays be proved to have actual equal velocities in the same medium, this hypothesis cannot represent nature. In this case too, nearly all the proposed explanations of dispersion become inadmissible. That suggested by Dr. Young and developed by Mr. Challis, of a resistance due to molecular inertia, would be excepted. This however seems not to have met with favor, and like its companions contains the defect of confounding change of velocity with change of direction.

In view of the general history of physical optics, the following propositions seem fully warranted.

1. The undulatory theory of light, in its application to the explanation of a vast range of observed optical facts, is eminently successful.

2. The Newtonian or emission theory, though perfectly representing many of the facts of light, entirely fails in many cases.

3. The unequal refrangibility or spectral dispersion of light, is the weak point of the undulatory, and the strong point of the emission theory.

4. No seemingly satisfactory explanation of dispersion under the undulatory theory has yet been given, which is not based on the hypothesis of finite intervals.

5. This hypothesis and all others now maintained, except that of the heterogeneous emission, are successful in explaining dispersion, only as they involve different velocities of propagation for the different colors.

6. If this difference of velocity be incompatible with natural facts, no theory involving it can stand without modification.

II. To show that luminous rays of different colors traverse the same medium with velocities sensibly equal, we need only to admit the contrary and trace its results. Suppose the red and violet rays to have unequal velocities of propagation V^r and V^v. Whatever else a ray of light may be, it is the trajectory of a series of impulses, which produce vision, and which take *time* in their passage from the radiant to the eye. Two ray impulses with unequal velocities V^r and V^v, simultaneously leaving the radiant, will traverse a space, S, in the same medium in unequal times, $T^r = \frac{S}{V^r}$ and $T^v = \frac{S}{V^v}$. If both the radiant and the eye are fixed, the eye simultaneously receives two luminous impulses, which left the radiant at two previous instants separated by a time $= T^v - T^r = T^{dif}$. A ray being a continuous series of these impulses perfectly alike, the eye, after both red and violet have reached it, would be acted on just as if T^{dif} did not exist, and would perceive this fact only by receiving R^r through the space T^{dif} before receiving R^v.

Let the eye receive a rapid motion, the radiant being still fixed. This motion combined with that of the impulses along R^r and R^v, will produce two resultants inclined to R^r and R^v, or astronomical aberration will result, with two values. The components of the earth's motion both along and perpendicular to these rays will be common, while the luminous motions along them are unequal. Calling V^e the earth's normal velocity, $V^e : V^r \pm$ the radial component of the earth's velocity, :: 1 : tang. aberration of R^r. While the tang. may be replaced by the arc, the difference of aberration of R^r and $R^v = \frac{V^r - V^v}{V^e}$. When V^r and V^v are sensibly unequal, two apparent radiants will result one red and one violet, whose angular distance equals $\frac{V^r - V^v}{V^e}$. A star emitting white light should then show as a colored spectrum with this elongation. Or as the actual maximum aberration is 20″·5, we have $\frac{V^r + V^v}{2} : V^r - V^v :: 20''5 :$ colored elongation. This spectral elongation would be distinctly visible if it exceeded the

minimum observable distance. But no such appearance is observed; hence a very low limit of possible values for $V^r - V^v$ is fixed: a value obviously too small to explain dispersion.

If a rapid motion be given to the radiant, a like spectral elongation will result from assigning unequal velocities to the different colored rays. The red ray would show a position of the radiant $T^v - T^r$ units of time later than that chosen by R^v simultaneously received. This spectral distortion would tend to correct or magnify that due to aberration, according as the earth and radiant have like or opposed motions. This should cause distortions of planetary discs and cometic nuclea, actually unobserved.

All instantaneous events, like eclipses and emersions of Jupiter's satellites occurring at great distances, should if $V^r > V^v$, finally disappear in violet, and first appear in red gradually growing white. The eclipses and emersions of Jupiter's satellites are so sharply defined, that they serve well for determining longitude. About 49′ 23″ may intervene between an event at Jupiter and our perception of it. About $1^h\ 26\frac{1}{2}'$ may pass after an eclipse or emersion of Saturn's satellites, before we see it. Yet their almost instantaneous transitions between light and darkness reveal to us no long lingering violet or swiftly rushing red.*

For fixed stars situated beyond the parallactic limit, the time required for propagating their light to us cannot be less than three years, but may be indefinitely greater. The star Algol or β Persei, "is usually visible as a star of the second magnitude, and such it continues for the space of $2^d\ 14^h$, when it *suddenly* begins to diminish in splendor, and in $3\frac{1}{2}$ hours is reduced to the fourth

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* After maturing in my own mind the previous ideas, my attention was attracted to the subjoined passage in Lloyd's Report, already mentioned. Why its applicability to a difference of chromatic velocities in all theories, was not perceived, I do not see.

"M. de Courtivon and Mr. Melville proposed to account for the dispersion of light by a difference in the initial velocity of the molecules, the red being swiftest and the violet slowest. But were such the cause of the phenomenon, the dispersion should be proportionate to the mean refraction. Indeed the hypothesis was abandoned almost as soon as proposed. Its authors had foreseen the consequence that, in the eclipses of Jupiter's satellites, the color of the light should vary just before immersion, and after emersion; and the existence of such an effect in the degree indicated by theory,† was completely disproved by the observations of Mr. Short. Another consequence of such a difference in the initial velocities of light of different colors is, that the aberration of the fixed stars should also vary with the nature of the light, and each star appear as a colored spectrum, whose length is parallel to the direction of the earth's motion."

† "The duration of this change, according to Mr. Melville, should amount to thirty two seconds, the velocities of the light of different colors being inversely as their refractive indices. This principle, however, as M. Clairaut has shown is obviously incorrect. It will easily appear that the initial velocities must vary inversely as the quantity $\sqrt{\mu^2 - 1}$, in order to account for dispersion; and that the duration of the expected phenomenon must be even greater than that assigned by Mr. Melville."

magnitude. It then begins again to increase, and in 3½ hours more is restored to its usual brightness, going through all its changes in $2^d\ 20^h\ 48^m$ or thereabouts."* Light occupies more than 7,500 times as long in reaching us from the parallactic limit beyond which Algol lies, as Algol does in changing between its maximum and minimum brightness. If we suppose V^r to be but 1-7500th greater than V^v, the red maxima would reach us simultaneously with the violet minima and conversely. Even this value would completely confuse the star's periodicity; and by increasing it, this peculiarity would be rapidly obliterated. These varying phases, marked with no chromatic changes or confusion, show beyond appeal that the extreme spectral elements of the light from Algol, cannot have velocities of transmission differing by even near 1-7500th their mean. How utterly incompetent then is any possible difference between the velocities of the different colored rays to explain dispersion. In the chromate of lead the dispersion is about one-fifth of the maximum refraction: compared with which any possible difference of chromatic velocities along the same line of media is wholly insignificant.

It seems needless farther to accumulate evidence of the fact that the rays of different colors, have *in nature*, velocities too nearly equal ever to serve for the explanation of dispersion. If M. Cauchy has shown that the hypothesis of finite intervals, yields sensible differences between their velocities, *it conflicts with facts*, and must retire from the domain of *physics* to that of *mathematics*. A powerful direct argument against this hypothesis as a fact in nature, is furnished by Ehrenberg's microscopic investigations into infusorial physiology. By a combination of actual measurements and physiological analogies, he concludes† that in certain cases of young monads, "the partitions of these monad-bellies will be but 1-4,800,000 to 1-6,400,000 of a French line in diameter, &c. I have besides seen rudiments of eyes in the monads to which I have given the name of *Microglena Monadina*, and which are 1-192 of a line in diameter. These often fire-red eye-points, appear in large infusoria, to be a fine granular red pigment, but whose granules perhaps first covered by many fine pigment granules, are small *lenses*, &c.; and although I will not lay particular stress on the fineness of these parts, yet the existence of eyes, however rudimentary they may be considered, allows of the possibility that even in the smallest species they may be present, and tends to lead us to a not so proximate finity of organic molecules; it may even give a *useful hint for considerations on the elements of colors and the theory of light*." This

* Sir J. F. W. Herschel, Treatise on Astronomy.

† Taylor's Scientific Memoirs, vol. i, Art. 28, p. 574.

distinguished naturalist has accumulated many equally striking proofs of the minuteness of this and other types of organic existences. More than 1500 of those "partitions of monad-bellies," would be required to make up by their *thickness, the mean length of a luminous wave*, or 1-50,000th of an inch. And can we doubt that these partitions are actually organized and that those eyes actually see? And does any one suppose the particles of ether, by which such vision must be effected, larger or more widely separated than atoms? But the length of a wave in a solid must include many thousands of atoms. The more we ponder on these *facts*, the more completely inadmissible does the physical hypothesis of finite intervals become. Not only does it lead to a result conflicting with fact, but it is, in itself most difficult to concede. Are we not then, in view of all the facts, justly entitled to infer, that *dispersion remains unexplained in the undulatory system.*

It may seem an inexcusable rashness, to express dissatisfaction with a demonstration so long honored, as that given by Huyghens for the law of refraction. Yet thinking that, though clear and sound and beautiful in mathematics, it is radically unsound in mechanics and wholly false to nature, I would ask a candid hearing to an honest argument. This demonstration turns on the retardation of velocity of plane waves entering a denser medium, with its converse, and on the composition of the primary wave by the series of secondary waves.

The wave theory, no less than that of emission, makes light to consist in a series of mechanical impulses, whose general trajectory in the same medium, is rectilinear. Now a simple and direct *retardation* or *acceleration* of such an impulse could not *change the direction* of its trajectory: another force or impulse must combine with this in order that its course may be broken or curved. I see not how refraction or flexure of luminous trajectives can result from mere retardation. Change of velocity cannot of itself produce change of direction. Refraction takes place at the dividing surface of media. If any oblique action be ascribed to such a surface as an elastic surface of impact, it should be to produce a flexure in the contrary direction to the observed refraction. Assuming a plane wave, perpendicular to a beam, as made up of an infinite number of elementary impulses, and obliquely incident on a denser or rarer medium; each impulse should according to all mechanical principles, continue on in a straight line, falling behind or advancing beyond the uniformly moving perpendicular plane, according to the time and rate of retardation or acceleration. The actual surface of impulses would thus become oblique to the direction of the beam, this direction remaining constantly unchanged. The postulate that the direction of the ray and the normal to the wave are identical, is whol-

ly unproved, unsustained by analyses and mechanics, and hence inadmissible.

Again the possibility of spherical waves of sensible intensity in all directions, like those imagined as secondary waves, is by no means clear. An impulse received by a surface atom or particle may give it a vibratory motion *in one direction, but not in all.* How can an equal intense wave be thrown off perpendicular to this line of vibration? These atoms and particles seem to be mere media of transmission for previously existing impulses, along their lineal direction of impact. Instead of *spherical secondary* waves of ether, the case seems to demand vibrating ethereal columns, much like sonorous vibrations in pipes. The rectilinear propagation of light, is only explicable on the wave theory by supposing the lateral oscillation a mere nullity. The exterior rays of a beam should otherwise create by their lateral action, new luminous waves not destroyed by interference. This cause could destroy only those lateral waves formed in the body of the beam. Besides, why should secondary waves be produced at surfaces and not equally through the whole mass of media? Or if all particles do produce such waves, why is not the side of a beam of rays in a material medium as luminous as its end? If all do not produce them, *where are the secondary waves in atmospheric refraction?*

But the objection drawn from dispersion has still greater force. The explanation of refraction, must from the nature of the case, contain that for dispersion when the difference between colors is given. That of Huyghens entirely fails of this. It does what is worse; admit it, and it proves that dispersion cannot exist; for facts show that the different colored rays have velocities sensibly equal in the same medium, and must therefore be equally refracted along the same line of media.

Huyghens' demonstration seems to me defective, not in its mathematics, but in its conflict with mechanical principles and observed facts. Geometrical construction and physical mechanics are independent provinces: the admission of a mathematical element not entering nature or the exclusion of one *actually* entering it, may lead to results wholly foreign to fact. The admission of the *element of velocity as the cause of refraction,* seems the fundamental error which has created the whole difficulty with dispersion. *Change of velocity is not change of direction,* and even though it could produce it, dispersion would demand an inequality of chromatic velocities which astronomy, from its celestial throne, emphatically denies. A position of dissent from generally received opinions is not to be coveted. Yet in matters of natural science the honest question is, Not, what says Paul or Aristotle, but what is the fact. Respect for great names, involves no obligation to cloak error, however honorable its pater-

nity. Much do I admire and respect Huyghens and his successors; still more do I admire and respect truth, and this would I exalt by eliminating error.

III. A brief outline of my own views of refraction and dispersion will conclude this article. Having been, for many months, engaged in comparing with nature, the results mathematically deducible from a particular physical law far exceeding in generality any yet developed; and having reached the subjoined views, solely by deduction from this law, it seems well here to state it, with its data and some of its consequences. DATA. 1. Matter is of *two kinds*, generically distinct: a chemical *atom* being the unit of one, and an *ether particle*, that of the other. 2. Particles are indefinitely smaller than atoms, and all particles are identical in form, force and volume. 3. A particular species of atoms, characterizes each chemical element; all individuals of each species being perfectly alike in form, force and volume. 4. All atoms and particles are immutable in form, force and volume. 5. Each atom and particle has inertia and hence maintains constant equilibrium. LAW.* *Material generic* LIKES *repel and* UNLIKES *attract each other inversely as the square of their distances.*

Under this law, each atom in an ether medium, forms an ether atmosphere, very dense at its surface, but soon becoming evanescent. A *molecule is an atom with its ether atmosphere.* Masses, gaseous, liquid or solid, consist of such molecules in mutual equilibrium. Molecules must attract or repel each other inversely as the square of their distance, (an approximation like the law.) Gravitation between masses is the resultant of the indefinitely great number of evanescent attractions between their component molecules. Cohesion is the resultant of the finite number of indefinitely great molecular attractions acting within the sphere of attractive evanescence. Gravitation and cohesion result from the same primary force, acting through sensible or insensible distances. Molecular repulsion is an *elastic ether tension* along the dividing surface between molecules, maintained by the converging atomic attractions on ether in their intervening spaces. A constant balance exists between this elastic tension and cohesion. Latent heat is molecular ether; sensible heat, disengaged ether, free to flow as air in wind; radiant heat *ether-transmitting waves*, and light ether non-transmitting waves. Crystallogenic forces, capillary attractions, elasticity, chemical affinity, statical and dynamical electricity with electrolysis, dia-magnetism, (magnetism I find the most refractory subject,) all receive clear and harmonious explanation under this one mechanical hypothesis.

* This law requires modification when applied between two units so near together that their lines of force action cannot be taken parallel in determining the resultant.

So unlimited and universal have I found its explanatory powers, that it is hard to resist the conviction of its being a physical verity. But wider still must its sphere of contact with nature be pushed, before it can be unhesitatingly pronounced, *a fact.* Yet has it already, for my mind, poured over nature so copious a flood of light, and revealed in the universe so profound a design, so sublime a system of legislation, so beneficent a group of most beautiful adaptations, that I have lost the power of neutrality and cannot but wish its truth. A single detached inference from a long connected series, is here presented in the following views of refraction and dispersion; views, which without the aid of the above law could scarcely have crossed my thought.

Any wave in an elastic medium, must have a portion of its mass denser than the surrounding medium. Consequently when the particles or molecules of this fluid have assumed a mutual equilibrium under the action of any local incessant force of attraction, *the waves themselves must be attracted.* In air at rest under terrestrial gravitation, a sonorous wave suddenly propagated, having a portion necessarily denser than the surrounding medium, is like a heavy floating body at each successive instant of time, and should therefore fall below a rectilinear course, in its actual trajectory of propagation. Suppose such a pulse discharged from the bore of a cannon and like ether pulses to be propagated only along its rectilinear course: it would describe a very flat projectile curve, by falling below the bore prolonged. The excess of density of the pulse only would cause this falling, for the air is buoyant—the amount of this excess divided by the mass of the pulse, would determine the distance fallen through in any time. This ratio would enter, in comparing the heights fallen through by different pulses. The constant change of particles in the pulse would not affect the result, for the action and composition of emanative force is instantaneous and incessant.

Refraction, I explain in a similar mode. The chief portion of the space in ordinary bodies is occupied by molecular ether, whose density in axial molecules based on axial atoms, and composing axial crystals, is along the dividing surfaces and through the interspaces, primarily dependent on the atomic axes, and secondarily on the molecular and crystalline axes. Take a medium in molecular equilibrium; any wave in the surrounding ethereal medium is attracted towards it like a buoyed heavy body; and though the particles of the wave are constantly shifting, all impressed attractions will be instantly and continuously combined with the wave impulse and so transmitted. A pulse propagated along a line will thus be deflected whenever the resultant of lateral attractions is inclined to its course as in the case of oblique incidence. This pulse being in a buoyant medium, it is only the action due to its excess of density over surrounding ether which

will deflect it. This excess and consequent deflection, being dependent on the nature of the wave, should vary with the color of the ray in light. This excess divided by the entire pulse and multiplied by a particular function depending on the time of action and intensity of the deflecting resultant, would measure the refraction. The physical elements entering are, the intensity of atomic attraction for the medium, and of repulsion between particles; the atomic radius on which the sphere of efficient action depends; the velocity of light which with the atomic radius will give the time function; and the specific densities of the incident waves, on the differences between which dispersion depends. The atomic or molecular attraction expressed in a series, after reaching a moderate number of terms, each counting one molecular diameter, becomes relatively very small, and the remainder of the series may be neglected in its summation—that is, molecular attraction becomes evanescent before reaching a sensible distance; its curve having both of the co-ordinate axes as asymptotes, when one is an axis of distance and the other of force. This is true if we even take the molecular diameter as great as the limit which observation shows it cannot actually exceed. A ray pulse then, obliquely incident, is attracted sensibly when it reaches an insensible distance from the refracting medium, and the more so as the pulses become specifically denser. The law of refraction and the values of the refractive index result as in the heterogeneous emission theory of Newton. The irrationality of dispersive refraction would follow an inequality between the atomic constants of media. The connection between density and refraction at once appears, and the chemico-mechanical peculiarities of oxygen even furnish a glimpse of the cause of the high refractive indices of inflammable media.

Whatever be the particular character of ethereal waves, they must, under the law, be subject to atomic attraction. To enter into an analysis of their mechanical peculiarities, is not here essential, nor have I the mathematical attainment, so difficult a subject demands. This would of course include heat waves, waves of chemical action or any others which exist; all of which having a specific excess of density must undergo attraction. The transversal vibration of luminous rays, is abundantly proved, and neither seems to touch or be touched by what has preceded. The difference between colored rays is in their amplitude of undulation, the violet or rather the lavender being shortest, and the red being longest; the former must be specifically densest, as being most refracted—the heating rays being still denser.

The ideas here so imperfectly sketched, combine, as is obvious, some points of the Newtonian and wave theories of light. Assigning to light the same mechanical nature as the latter, the reason of refractive deviation is derived essentially from the former.

In reality forming a compromise between the two, what about these views is peculiar, came deductively from another independent source. I submit them with no wish for their adoption if they do not bring us nearer to nature. If there be error in them, time and criticism will eradicate it; if truth, science will appropriate it and thus be relieved from a present reproach. Finally and with regret must I own, that my mind is too much overtasked to permit of now making that clear and full development, usually and justly demanded in support of new views.

West Point, N. Y., Feb. 9, 1849.

ART. XXXIII.—*Polarization of Galvanic Light;* by CHAS. G. PAGE, M D., Prof. Chem. National Med. College, Washington, D. C., Examiner of Patents, P. O. U. S. A.

HAVING seen it stated* upon the authority of Arago, that the light of the galvanic arc, like that from incandescent gas was not polarizable, I have been induced to repeat the experiment with a view of testing for my own satisfaction, a principle so important in a theoretical point of view. The experiment was briefly performed and only with reference to the simple fact itself. The battery employed was a Grove's, of fifty pairs, platinum plates four inches square and double surface of zinc. By means of a Nicols prism and one reflexion from a plate of mica, the light from the arc between the charcoal points was distinctly polarized. Its property in this respect was much more decided when the arc was first formed than when it had continued for a few seconds. It may be observed, that when the electrodes are first withdrawn the arc is very intense, and does not rise in the arched form immediately; but as soon as the charcoal points have become intensely heated, the arc becomes elongated and rises, from the upward current of air, and the upper portion of the arc is then feeble in intensity. This upper portion did not appear at all polarizable upon a single reflection, but upon two reflections was decidedly so.

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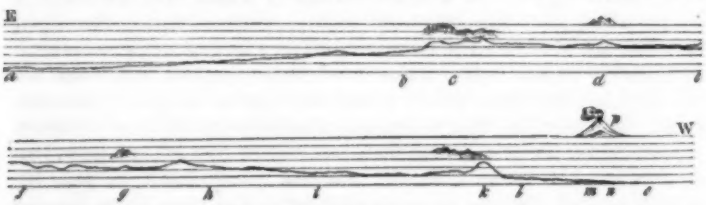
* Being poorly supplied with journals and very much occupied in official labors, I have been obliged to take the statement as I find it in several works of high repute upon the subject of galvanism, &c.

Washington, Feb. 19, 1849.

ART. XXXIV.—*Observations on some points in the Physical Geography of Oregon and Upper California;* by JAMES D. DANA.*

THE heights of the Rocky mountains which form the natural division between the territory of Middle and Western America, range along a nearly north-northeast course at a distance of six to eight hundred miles from the Pacific coast. These mountains properly include the whole breadth of country west of the Mississippi plains. The swelling of the land begins from western Missouri and very slowly rises with a slope not exceeding seven or eight feet to the mile, until it reaches an elevation of five to eight thousand feet. About the summit the surface becomes broken with ridges that rise still higher by three to six thousand feet, and the Wind River mountains, according to Fremont, stand with their bleak tops 13,570 above the sea. The traveller makes his journey by the South Pass,† without an ascent beyond 7,490 feet, and the difficulties are so slight that loaded wagons may be transported across. Thence after a while a descent is commenced, and although hills and mountain ridges are encountered, the surface, viewed in its wide extent, continues to decline to the ocean. The accompanying sections, one from Fremont,‡ the other from Emory,§ are excellent illustrations of this great feature in the physical geography of the west. The ridges at top



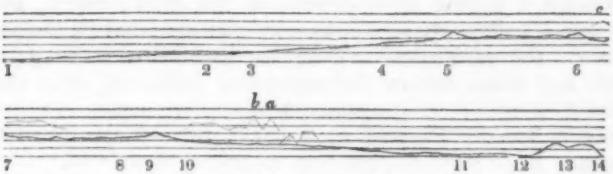
Profile of the route from the mouth of the Kansas to the Pacific, by J. C. Fremont, in 1843. Vertical scale to horizontal as 30 to 1. The intervals between the horizontal lines are each 2,000 feet; *a.* Mouth of Kansas River. *b.* St. Vrain's Fort. *c.* Laramie River. *d.* South Pass. *e.* Dividing range. *f.* Beer Springs. *g.* Great Salt Lake. *h.* Fort Hall. *i.* Crossing of Snake River. *k.* Blue Mountains. *l.* Fort Wallawalla. *m.* Dalles. *n.* Cascades. *o.* Fort Vancouver. *p.* Mount St. Helen's.

* In part from the Author's Geological Report of Exp. Exped. under Capt. C. Wilkes, U. S. N.

† The South Pass is at the headwaters of the North Fork of the Nebraska or Platte River. Lewis and Clarke's Pass is at the headwaters of the Jefferson river, a branch of the Yellow Stone; it is covered with snow.

‡ Rep. Expl. Exped., to the Rocky Mountains, in 1842, to Oregon and California, in 1843, 1844; by Brevet Captain J. C. Fremont. Washington, 1845. See this Jour., iii, 192. 1847.

§ Notes on a Military Reconnoisance from Fort Leavenworth in Missouri, to San Diego in California, in 1846; by Brevet Major W. H. Emory. See this Jour., vi, 367, 1848.

and over the sides are but crests or embossments on this great swelling elevation; its whole breadth exceeds fifteen hundred miles.

Section from Fort Leavenworth, Mo., by the Gila, to San Diego, on the Pacific, by Brev. Maj. Emory; scale as in the preceding figure. 1. Fort Leavenworth. 2. Pawnee Fork. 3. Jackson's grove. 3 to 4. Valley of the Arkansas. 5. Raton Summit. 6. Santa Fe. 7. Rio del Norte. 7–8. Valley of the R. del Norte. 9. Ben Moore. 10–11. Valley of the Gila. 12. A Salt Lake. 13. California Mountains. 14. San Diego, on the Pacific. *a.* Mt. Turnbull. *b.* Mt. Graham. *c.* Zandia.

Such is the elevated *Pacific* border of our continent. On the east, the Appalachians, an humbler range extending from Maine to Georgia, form the *Atlantic* border. Between the two lie the vast plains of the Mississippi, a river stretching its arms on one side far among the Atlantic heights, and on the other reaching to the Rocky mountain summits.

By these great natural features, the continent of North America is divided, as has often been stated, into (1.) an Atlantic slope, one to three hundred miles in width, (2.) a middle section between the summits of the Appalachians and Rocky range, fifteen hundred to two thousand miles broad, and (3.) the Pacific slope already alluded to. The last of these divisions constitutes North Western America. Its extent of surface from latitude 49° to the Gila, is about 867,541 square miles; of this 526,078 belong to the recent acquisition from Mexico.*

In the following pages, we remark:—I. on the peculiarities of the coast line; II. on the mountains and their courses; III. on the general courses and characters of the valleys and rivers; IV. on the distribution of forest vegetation and V, its relation to the climate. We do not propose to enter minutely into geographical details, but rather to touch upon such facts as illustrate certain prominent points in the physical geography of the territory.

I. *The Coast.*—The first thing that strikes the eye on a map of the territory is the peculiarity of the coast line, and its near parallelism with the mountains. Along by Mexico and California the coast trends nearly northwest-by-north, or more correctly N., 38° W. At the parallel of 40° it bends north, pursues a northerly course as far as the straits of De Fuca, just beyond 48° N., and then trends off again to the northwest-by-north parallel nearly with the California line. Although little more than an

* Message of the President U. S. to Congress, Dec. 5, 1848.

approximate parallelism to a range seven hundred miles distant is to be expected, it is interesting to observe that the Oregon portion, having the north and south course, has, according to the best maps, a parallel representative in the Rocky range; and if the map is held so that the coast and mountains have a horizontal position, the parallelism will appear somewhat striking;—the north and south line in the mountains beginning as it should about 4° north of its commencement on the coast.

South, toward Panama, the trend of the mountains and coast becomes more westerly, bending around to N. 62° W.

To the south of the straits of De Fuca, the outline of the coast is but little varied by bays. The only great indentation is made by the Californian gulf. This gulf, (the sea of Cortes, and Vermilion sea of the early Spaniards,*) sets into the land abruptly between 20° and 23° N., and then pursues a northwesterly course, parallel with the coast to 32° 20′, just inside of a range of mountains, making a total length of seven hundred miles, with an average breadth of one hundred miles. North of the Californian Peninsula lies the bay of San Diego, a good land-locked harbor four or five miles long, considered by Emory to be among the best retreats for shipping on the coast. Monterey farther north near latitude 36° 38′ is an open roadstead. The bay of Francisco† in latitude 37° 48′ ranks next in size to the Californian gulf. It

* This gulf was discovered by a vessel detached from the Expedition of Cortes in 1533, and Ximenes the commander was murdered soon after. Hernando de Grixalva entered it in 1534, and Cortes in 1536. The Colorado was first discovered by Padre Francisco Kino in 1700. Until the middle of the 17th century, the peninsula was supposed to be detached from the main land, and called *Islas Carolinas*. It was shown to be a peninsula by Francisco de Ulloa in 1699, and also by Eusebius Kino in 1701. The country adjoining the gulf on the east was the Nueva Gallicia of the Spaniards, including the subdivisions, (commencing on the south,) Xalisco, Chismetta, Couliacan, and Cinoloa, together with Guadelajara, Zacatecas, and Cibola, beyond in the interior; the last mentioned lying a little to the north of east of the head of the gulf. It is said of Cibola, that it yielded cotton wool, "by reason whereof the men and women wear better apparel for the most part than elsewhere." The Pijmos and Maricopos tribes of the same region, on the Gila, visited by Emory, cultivate cotton. Some ruins of buildings in that territory are attributed by E. G. Squier, on apparently good evidence, to the early Cibolans.

† This bay is supposed to have been first entered by Sir Francis Drake in 1578. He surveyed this coast up as far as latitude 48°, and called it New Albion, from seeing white cliffs near Point (Punta) de los Reyes, a few miles northeast of Francisco. June 17, he entered what he describes as a large bay and remained there for some time; and as this is the only place on the coast which at all answers to his description, or could have afforded him good anchorage for the time he was there, it has been supposed that he erred in his determination of its latitude, which he places in 38° 30′, instead of 37° 48′. The bay was discovered again in 1595 by a Spanish ship called San Augustin. Sebastian Vizcaino surveyed the coast in 1603, and discovered the harbor of San Diego. The coast from 40° to 44° was first explored by Juan Cobrillo, in 1542, and Cape Mendocino was named by him in honor of Don Antonio de Mendoça, then viceroy of New Spain. He failed of discovering the Columbia river, which was not entered till 1792, by Captain Robert Gray of this country, in the ship Columbia.

The town of Francisco is south of the neck that forms the entrance to the bay, about four miles from the sea.

opens through a passage one mile wide and five long, bounded by high hills, and then expands east and south into two broad, deep arms, each about thirty miles long and two to twelve miles wide. The southern arm has the trend of the coast. North of Francisco, there is a small bay at Bodega near 38° 20′, another called Gray's Harbor in 46° 50′, and the entrance to the Columbia in 46° 20′. The Columbia has a mouth seven miles in width, and the waters within afford good anchorage though reached by a somewhat difficult channel, which is wholly impassable in bad weather.

It is thus seen that from the Californian peninsula to latitude 48°, the outline of the coast is comparatively even. We are especially struck with this unbroken character, when we consider that the coast is closely bordered by high land, and thus differs widely from the Atlantic side of the continent.

North of 48°, there is a remarkable change in its features. In the first place, the continent is abruptly narrowed one hundred and fifty miles, and Vancouver's Island and others appear as the exscinded fragments. Moreover, instead of a gently undulating shore-line, the coast is cut through by a large number of narrow channels, running far into the land, like the fiords of Norway, and so deep and abrupt, that large vessels may sail with their yards amid the foliage of the shores, or rub their sides against their rocky outline, before the keel touches bottom. These deep but narrow channels have the most irregular forms, often extending to a length of fifty or sixty miles, and by their intersections making a complete network of water, for internal navigation. On a map, the intersecting channels look like a fringe to the coast—a fringe thirty to sixty miles broad. After entering the straits of De Fuca, south of Vancouver's Island, and sailing one hundred and fifty miles, some of these branching fiords extending south are reached; and a vessel bound to Nisqually winds along through Admiralty Inlet for another one hundred miles before reaching that harbor. These still inland channels are often bounded by lofty shores, sometimes rising into palisades, which are densely covered with forests.

These fiords prevail along the coast to the Russian settlements; islands are also numerous along the whole distance, varying in size from points of rock to the dimensions of Vancouver's, which measures nearly three hundred miles in length, and averages forty in breadth. The islands too have their deep fiords, especially on the oceanic side.

It is interesting to observe in this connection, that similar fiords occur upon nearly all coasts in corresponding high latitudes, while at the same time, the world over, they are almost wholly absent in the lower temperate and torrid zones. On Eastern America, the coast is singularly even in its outline until approaching

Maine. But north of latitude 43° even to Greenland, as any good map will show, the fiords are numerous, deep, and intricate in their ramifications. In South America, beyond the parallel of 42°, they begin to characterize the coast, especially the western, and long narrow channels of water become exceedingly numerous. Tierra del Fuego is cut through by them and severed into many parts. Moreover, Chiloe and numerous islands stand off the coast like Vancouver's and others of northern America. *North* of 42°, the coast has few bays and consequently an even outline.

In Europe, the fiords of Norway and the deep bays of Scotland are well known; the coast contrasts strikingly with the outline of France, Spain, and Africa. The African continent does not reach below lat. 36° and has a simple outline throughout.

There are then certain fiord latitudes—or *a fiord zone* for the globe, both north and south of the equator. New Zealand and the Auckland and other islands partake much of the same character, and are the only lands in the southern hemisphere besides the extremity of America, which reach into the southern fiord zone. These facts lead to interesting conclusions respecting extended areas of subsidence encircling our globe; for the fiords may be shown to be former valleys of the land now filled with the sea: but we pass on with this bare allusion to the subject.*

II. *Mountains.*—The parallelism between the coast and the line of the Rocky Mountains has been remarked upon. The same parallelism characterizes a large part of the great features of the surface.

1. The most prominent of the lofty dividing lines of heights, lies about 150 miles from the coast and separates a Western section from the interior of the territory. It is called the *Cascade Range* in Oregon, from its crossing the Columbia at a place named from its rapids, the Cascades. In California, the Cascade range gives way to another ridge,—the Sierra Nevada or Snowy mountains. The two are properly one long chain of mountains; yet instead of being continuous, the Oregon range gradually dies out in Northern California, while the Sierra Nevada is rising to its snowy altitude on a meridian a little farther to the east, exemplifying a common feature of the constituent parts of mountain chains—their interrupted continuity with overlapping ends, rather than a direct lineal course;—a feature which if mountains were more carefully studied, would be oftener discovered and marked on our maps.

The Cascade Range has a nearly north and south course. Although in general more than one hundred miles from the sea, it approaches the coast near Puget's Sound, and obviously because

* Geol. Report Expl. Exped., p. 675.

the waters of the ocean here have made a deep inroad into the land, rather than from a change of direction in the range. Its limits to the north are not fully ascertained, yet from the best information at hand, it appears to reach far into the Russian territory. It constitutes a barrier to commercial intercourse with the coast except along the single great highway the Columbia. Fraser's river, near latitude 49°, has also obtained a passage through these mountains; but it plunges along in a succession of cataracts.

In the course of the six hundred miles from Fraser's River to the Sacramento, latitudes 50° to 40°, the range contains seven snowy peaks, varying from *ten* to *fifteen* or *sixteen thousand feet* in height,—three north of the Columbia, and the others south. Commencing at the north, they are *Baker*, *Rainier*, *St. Helens*, *Hood*, *Jefferson* or *Vancouver*, *McLaughlin* or *Pitt*, and *Mount Shasty*.

The main body of the Cascade range in Oregon is not over five or six thousand feet in elevation. Its heights are therefore but hills in comparison with the lofty cones above enumerated which rise out of the chain. In no part of the world, not even beneath the Andes, has the writer been as deeply impressed with the sublime in mountain scenery, as when in sight of these towering peaks. There are no rival heights around: they stand alone in solitary grandeur, wrapped about with perpetual snows. Mount Rainier is in full view from the plains of Nisqually. Mount St. Helens forms one of the landmarks seen in approaching the coast. It is not less than 15,000 feet in height, and has been estimated at 16,000 feet; the snows form an unbroken mantle descending half way to its base. Mount Hood, of somewhat less altitude, is in sight from Vancouver. It stands majestic among low crouching hills, with rugged frowning features,—its summit enveloped about with a ragged coat of snow that half covers its black rocks. Mount Shasty is another of these hoary peaks: a view of its double summit is given at page 250. All these cones were once active volcanoes, and Rainier and St. Helens are said still to give off vapors and occasional showers of ashes. Intermediate parts of the range consist of granitic, hornblende, talcose and other rocks.

The Sierra Nevada has a greater average altitude than the Cascade range, and to a large extent is covered with snows. We are not yet informed whether any of its peaks rise into solitary cones, like those of Oregon. But the information obtained renders it probable that they consist largely of granite and slate rocks. The pass travelled by Fremont, near the head of the American Fork, in latitude 38° 44′, was found to be 9,338 feet high—two thousand feet higher than the South Pass of the Rocky Mountains—and points in the range near by, rose above him several thousand feet. Again, at the head of Salmon Trout river in

latitude 39° 17′ 12″, "the usual emigrant pass," the height was 7,200 feet. The same range where passed by Emory, east of San Diego just north of 33°, was little over 3,000 feet in altitude. The same mountains continued south, constitute the range of heights forming the Californian peninsula.

We pass now from these brief remarks upon the great dividing range of the territory to the sections east and west.

2. The mountains of the *Eastern section* have in general a parallelism with the Rocky chain, or else a direction *transverse* to this course. The Blue mountains, lie nearly parallel with the Cascade range, and bound the region of the Southern fork of the Columbia (Lewis or Snake river) on the west. North of this fork the range ceases; but beyond the northern Columbia other ridges continue its northward course. These mountains are eight to nine thousand feet high, and four thousand feet at the pass. The Grand Rond is a large circular valley in the mountains measuring fifteen miles by twelve in its diameters; it is a fertile prairie shut in by high walls of basalt and situated about three thousand feet above the sea.

South of the Blue range, between the districts of Snake river and the Colorado, a vast territory four hundred miles in longitude by two hundred and fifty in latitude, is called by Fremont, "the Great Basin"—a region of lakes without outlets, of few rivers, and these without mouths, of salines and salt efflorescences,—yet of some green spots amid wide regions of aridity. Even here, according to the map of this explorer,* the mountain ridges of the Basin, rising two to five thousand feet above its level, have generally a north and south direction. The courses of the limiting ranges of this great area are yet to be determined. Crossing the Sierra Nevada, Fremont found the western or Sacramento foot, five hundred feet above the sea, the eastern four thousand feet; and the whole of this "Great Basin" (excluding its mountains) from east to west ranged in altitude above the sea from four to six thousand feet. The Great Salt Lake near its Eastern limit, is 4,500 feet above the ocean, and Pyramid lake,† a beautiful body of water twenty-five miles long, near the eastern foot of the Sierra Nevada, is 4,890 feet.

This Basin is therefore a peculiar feature of the western territory. Instead of the usual western slope of the Great Rocky Range, there is here no proper descent to the westward of the Salt Lake, until crossing the Sierra Nevada. This is seen in the following profile section reduced from Fremont's.

The contrast with other parts is well shown by comparison with the sections on pages 376, 377, one along the Columbia, and the other by the river Gila.

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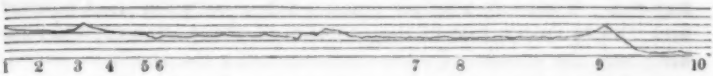
* Geog. Mem. upon Upper California. 1848.
† This Journal, ii ser., iii, 201, 1847.

The height above the sea of Wallawalla at the forks of the Columbia is but 1,286 feet.



Profile of the route from the South Pass across the Great Basin to Francisco Bay, by J. C. Fremont in 1845. Spaces between the parallel lines each 2000 feet; horizontal scale one-thirtieth the vertical. 1. South Pass. 2. Green River. 3. Bear River Mountains. 4. Beer or Soda Spring. 5. Mouth of Bear River. 6. Great Salt Lake. 7. Humboldt R. valley. 8. Humboldt Lake. 9. Sierra Nevada. 10. Francisco Bay.

Among the east and west or *transverse* ranges in this eastern section, there are the Salmon river mountains and the Spokane range in Oregon: and the northern and southern limits of the Great Basin are laid down by Fremont with the same direction.

3. The region west of the Cascade Range, or *Western Section* of the Territory, is bordered on the coast side by a mountainous region varying from a few hundred to five thousand feet in height, yet mostly below three thousand feet. It occupies a breadth of ten to fifty miles near the sea, constituting a very broken country, and in some parts consisting of two or three parallel ridges. The general direction is parallel with the coast and the Cascade Range, conforming thus to the great system of the West. A few lofty peaks to the north rise beyond the snow limit. Mt. Olympus, south of the straits of De Fuca, is a high peak, probably extinct volcanic, having an altitude as Captain Wilkes states, of 8,138 feet. Mount Fairweather, 15,000 feet high, and Mount St. Elias, 17,000 feet, near latitude 60° N., properly belong with the Coast Mountains. Swalalahos is an ancient crater, south of Astoria, and not far from 3000 feet in height. East of Francisco, Mt. Diavolo, according to Fremont, is 3,770 feet high.

The subdivision of the Coast Range into parallel ridges is well seen south of the Bay of Francisco, and it is also as decided in some parts north.

Besides the north and south ridges, there are others of a transverse course, or east and west direction. The Elk Mountains near latitude 43° 40′, the Umpqua mountains in latitude 42° 50′, and the Shasty just north of 41°, are natural boundaries, extending east and west across the western section of the territory, and dividing it into geographical districts,—the *Umpqua*, and the *Shasty*, with the *Willammet* on the north, and the *Sacramento* on the south. The Elk Mountains were crossed by the writer about thirty miles from the sea, and in this part they were 1,200 to 1,500 feet in height. The Umpqua mountains, nearly at the same distance inland, were 2,000 to 2,500 feet in height—a steep and rugged collection of ridges. The Shasty mountains, west of the Shasty Peak, were from 2,000 to 6,000 feet high,

and covered the country for a breadth of forty miles in latitude, forming thus a wide barrier between the Shasty and Sacramento regions. There is another smaller ridge between the Clammat and Shasty rivers, east of the junction of these streams, and situated near the parallel of 42°; as it lay along the southern boundary of Oregon, we called it the *Boundary Range*. It was about 1,200 feet high at our pass, and some of its peaks rose to 1,500 feet.

III. *Rivers and Valleys.*—The peculiar arrangement of the mountains parallel with the coast, gives necessarily a corresponding course to the valleys and rivers. Instead of opening on the sea, the valleys are shut off from the sea by one or more mountain ranges, and the facilities of intercourse in a north and south direction, are far greater than from west to east.* Indeed, as already stated, the long Cascade range proves an almost insurmountable barrier for merchandise, except along the passage cut through it by the Columbia: and it was with full knowledge of this difficulty, especially over northern Oregon and the territory beyond, that led Great Britain to insist so earnestly upon extending her rights south so as to share at least in the benefits of this highway.

The Columbia, just west of the Blue Mountains, near Wallawalla takes an abrupt bend and forks. The southern fork, or Lewis River, curves around the northern extremity of this range, and then follows its eastern side far to the southward and eastward. The northern fork follows a nearly north and south course (parallel with the line of direction of the Blue Mountains) for one hundred and fifty miles from the forks, then stretches east till a chain corresponding to the Blue Range is passed; then strikes north again, rising gradually towards the summits of the Rocky Mountains. Its course in this its upper part indicates still other ridges with the prevalent direction. For in latitude 49° it widely forks, and the two branches flow in opposite directions; one (Flat or Kootanie river) extending southeast parallel with Lewis river to latitude 48°, then returning nearly upon its course, and running north and south for one hundred and sixty miles near the crest of the Rocky Mountains; the other branch (the Columbia proper) stretches northerly to latitude 52°, then curves short around and after one hundred and eighty

* The transverse ranges of Southern Oregon, separating the Williammet, Umpqua, Shasty and Sacramento districts, are an impediment in the way of an easy construction of roads (especially railroads) from north to south. The Shasty mountains particularly, (see page 253 of this volume,) are a serious obstruction. It is however possible, that by the course of the Sacramento to the east of the Shasty Peak, and then by the Clammat from its source, a feasible but circuitous route may be found: and passes through the Umpqua and Elk mountains may possibly be discovered either to the east or west of our route.

miles in its new direction, finds its source within a few miles of the head of Flat or Kootanie river. Viewing the river in its general course, we have the following lines, parallel nearly in direction with the Rocky Mountain range.

1. The headwaters of the Columbia and Kootanie, along the crest of the mountains; the two together about 350 miles.

2. The continuation of these rivers (after their reversed course) to their junction;—another 350 miles.

3. The great bend from Fort Okonagan to Fort Wallawalla; about 150 miles,—not counting the irregularities.

4. The general range of Lewis river, east of the Blue mountains.

5. A north and south portion, just west of Vancouver, 40 miles in length.

At the same time, the intermediate parts of the river have a *transverse* course.

We thus see how the long parallel mountain ranges, by acting as barriers to the waters that flow from the mountains to the sea, have compelled the river to bend north and south, with many turns and long reaches—like the track of a vessel beating against a head wind—before it terminated its course in the ocean. The whole interior for a length of 800 miles, north and south, (latitude 42° to 50°,) finds an outlet for its waters through the Cascade range, by this single channel.

The fact stated of the Columbia is a general truth for the whole western territory. A north and south course is marked in nearly all the features of the country. Between the Blue mountains and the Cascade Range, the Fall or Chutes river flows from a point 180 miles south. John Day's creek is another smaller stream a little to the east of Fall river. At the northern extremity of the great bend in the Columbia, near Okanagan, the Okanagan river empties, having flowed from the north, over 150 miles, parallel with the north branch of the Columbia, so that this river and the Columbia below its mouth together, make a continuous north and south line 300 miles long. Fraser's river farther north, has a north and south course, of 300 miles, independent of its windings.

Passing to the *Western* Section, the same peculiarity is observed. The intervals between the Cascade and Coast Ranges is a vast trough extending north and south, containing the Willammet river on the north and the Sacramento (with the Joaquin) on the south. The Willammet valley, south of the Columbia, including the region of its tributaries, covers an average breadth of sixty miles, and extends south to the Elk mountains, a distance of 140 miles. A bend in the Columbia, at the mouth of the Willammet, throws forty miles of the former river into a north and south course corresponding with that of the latter; and from the

north, the *Cowlitz* enters: so that the whole Willammet depression of the surface is 200 miles long. South of the Elk mountains, the transverse ranges have given rise to small east and west streams, the Umpqua and Clammat. But beyond the Shasty mountains in that direction, we open on the magnificent valley of the Sacramento, which is one with that of the San Joaquin, the two rivers flowing in opposite directions from the extremities of the long basin, and joining their waters near its center, to flow together into Francisco Bay. The valley is 450 miles long; its alluvial country ten to sixty miles; and the tributaries embrace a breadth of sixty to one hundred. The river receives its principal head waters from the eastward through a break in the Cascade range near the Shasty peak. Just before leaving the Shasty mountains on our overland excursion, this stream was seen uniting its more copious waters with those of the tributary (Destruction river) followed down by our party.

Among the coast mountains themselves, and the minor features of the country, there is a marked correspondence to this north-and-south system. Near Astoria, Young's creek flows from the south, and is thirty miles or more long. The southern arm of the Bay of Francisco lies between ridges of the Coast range, which are two to five thousand feet high, and the same valley extends to the latitude of Monterey. Here, another shore ridge commences, and the valley of the Buenaventura, partly a continuation of the preceding, stretches on south for 150 miles. The overlapping ends of the shore ridges just north and south of Monterey are worthy of note. The Bay of San Diego has a similar parallelism with the coast in its longer diameter. The streams north of Francisco conform to the same system. The gulf of California, moreover, is nothing but a great trough between north-and-south ranges of heights, though bounded by a comparatively low country on the east.

This character of the country has a vast influence upon its agricultural resources. Not only have the waters been compelled to collect into large rivers, the most favorable for navigation, but by this arrangement they have been retained long on the land to fertilize its surface. The beds of the streams instead of having a rapid descent in these hilly regions, and in place of containing a torrent that should waste in the sea the debris of the mountains, are gentle in inclination along their lengthened course; the waters spread wide their floods, and distribute their alluvium over a large surface, giving great extent to the fertile bottom lands. The contrast is at once seen if the region of the Sacramento and Joaquin is compared with the Shasty and Umpqua districts farther north, where the rivers are small and run in rapids the greater part of their course, and their flats are contracted though including some good land.

IV. *Forest and prairie regions.*—The valleys and mountain ridges vary in their productions, appearance, and climate, according to their greater or less proximity to the sea, and the height of the land above the ocean's level.

The general character of the Sacramento plains,—their wide extent—their upper and lower prairies—the openness of the land, with only scattered oaks where there are trees at all, were subjects of remark in a former article, (p. 247.) The Willammet is a similar region. It includes extensive flat prairies—the alluvial plains of the river—lying at two levels, the upper about fifty feet above the lower. These prairies are one to fifteen miles in width, and on either side, rise into rolling grassy hills, a hundred to a thousand feet high. The whole breadth of the prairie region, including hill and plain, is said to be sixty or seventy miles. The river, winding through the prairie, lies between banks twenty to twenty-five feet high in the dry season, and is bordered by a line of trees and shrubbery. A similar border of pines and cottonwood fringes each of the tributary streamlets, and in a view from an adjoining hill, the water-courses are traced in their meanderings through the plain by these threads of forest. The open prairie is dotted with distant oaks and covered thinly with grass growing in scattered tufts eighteen to twenty inches apart. The soil is in general good, and where the hills are unfavorable for cultivation, they may afford excellent pasturage.

Such are the prominent characters of the Willammet district. Other rivers have similar prairies varying with the size of the streams. There are small plains about Champooig, just west of Willammet, near a creek and some lakes. On the Cowlitz north of the Columbia and also about the upper part of the Chikelis the prairies have much beauty. Upon the lower Columbia prairies exist near Vancouver, though not extensive; but for the greater part of the distance west, to within twenty-five miles of the sea, the banks of this river are mostly palisades of basaltic rock one to two hundred feet high; for the last twenty-five miles there is a change to tertiary sandstone and shale with only an occasional dike of basalt. In the Umpqua and Shasty or Clammat districts there are other open prairies over hill and plain, though of less extent; moreover they are not as productive, owing to the prevalence in some parts of talcose or hornblendic rocks, and of sandstone in others.*

* From the Columbia to the Umpqua, the prevailing rocks were the Astoria tertiary sandstone. But south through the Umpqua mountains, there were talcose and hornblendic rocks and a siliceous puddingstone, producing rugged features in the landscape, and giving abrupt and broken slopes to the hills. Hornblendic rocks and granite continued to prevail south beyond the Shasty. Then (in the Clammat region) appeared sandstone and basalt again and afterwards serpentine, syenite, trachyte, granite, talcose and other rocks as explained on pages 250–257.

But in the vicinity of the sea the country instead of being open prairie is covered with forests of evergreens. In Oregon these prevail over the larger part of a breadth of thirty miles along the coast. In the vicinity of Astoria, as has been mentioned by various travellers over the region, the trees of the dense woods are extremely large—two hundred and fifty to three hundred feet being a common height. In July, 1841, on an excursion to Mt. Swalalahos, twenty-five miles south of Astoria, we travelled over a heavily timbered undulating country, passing trees occasionally twenty-five feet in circumference; and one measured was thirty-seven feet. In some places the fallen trunks of trees (pines, hemlock, spruce, and alders) so obstructed the way, that we were compelled to travel upon them, passing from one to another, seeing the ground ten to fifteen feet below us. The soil was generally good, and supported a thick growth of underbrush. There were flats near Chishuk's river, but they were covered with forests.

The country of the Western Section is thus divided longitudinally into a forest and prairie portion, the former densely wooded, the latter bearing only scattered oaks, and lines of forest along the streams. Yet in these prairie districts, elevations over one thousand feet high are wooded like the coast region, and the forests extend down their slopes, especially the northern and western, nearly or quite to their bases. Elk mountain and the Umpqua ridges were thus densely clothed with forests.

Beyond the Cascade Mountains, in the Eastern Section, even the forest-border to the rivers fails to a considerable extent, and the woods are confined to still higher ridges. And beyond the Blue Ridge, to the summits of the Rocky Mountains, there are few arable spots in a region of wide sterility.

North of the Columbia this coast region of forests widens, while to the *south* it gradually narrows. Near Francisco Bay the lower hills are mostly bare of trees, or support only grass and shrubbery. Only the ridges of the coast range, a thousand feet in altitude and higher, are well wooded, and produce the famous cedars of the region. Going farther south, the forests of the ridges are confined to those of still greater height; and in the Californian Peninsula, as travellers affirm, the mountains are bare to their summits. The region is a collection of lofty ridges, wild and rugged, overrun with rocks and sand, and mostly bare of verdure. The Cerro de la Giganta is 4,500 to 5000 feet high. Only two small streams enter the sea on the west, and none on the east. Humboldt says, where there is soil there is no water, and where water, nothing but rocks.

Thus whether we recede inland from the coast, or southward along its course, forest vegetation gradually diminishes; while going northward it increases in extent. The lower lands are

wooded about Astoria,—only the hills or mountains near Francisco,—and not even the loftier ridges in the Peninsula of California. Lines of equal forest growth—supposing the surface at a corresponding level and uniform throughout—would very slowly diverge from the coast as we follow them north in California, a little more rapidly in southern Oregon, and still more so to the north of the Columbia: such lines would curve, as we have reason to believe, with a regularly varying curvature.

Exceptions to such regular courses in these lines necessarily proceed from inequalities of surface, the varying direction of the coast, and from the moisture of springs in low lands. It is also a common fact that where hills of five to eight hundred feet are bare of trees throughout, those of twelve hundred will be wooded to their bases, owing to the moisture which these higher ridges condense to be thence carried down the slopes.

V. *Climatal cause of the distribution of forest and prairie regions.*—The peculiarities mentioned, run parallel with other facts relating to the climate: and the parallelism is so exact, that we cannot fail to recognize the cause of the former in the latter. A full series of meteorological observations for the territory has not yet been made. But it is sufficient for the present purpose to know that the rainy season in the Willammet (lat. 45° to 46°) continues through five to seven months, the colder months of the year; while on the lower Sacramento—about latitude 38°—it is usually confined to three or four months. The rains ceasing, the grass dries up in the course of the following one or two months, and remains as dry fodder for the cattle through the rest of the year, the juices being retained in consequence of the completeness of the drought. This was the condition of the plains when traversed by the writer in August, September and October of 1841. In Oregon in the month of August, the lofty cones of St. Helens and Mt. Hood, though piercing far into the region of perpetual snows, were unobscured to their summits—standing as natural hygrometers, indicating the dryness of the season at every height to 15,000 feet. There was occasionally a light haze in the atmosphere, but rarely a cloud. This is widely different from the condition of the much lower mountains of Eastern America. There was no rain during the journey from Vancouver to Francisco. The remarks here made apply particularly to the region between the Cascade and Coast Mountains, or *over* thirty miles from the sea.

Within the Coast region, where forests prevail, the mists of summer are frequent and extremely copious, almost or quite amounting at times to rain. On ascending the Columbia, we passed abruptly about forty miles from its mouth, from a region of dense fog, to sunshine; and looking back, the mist seemed to stand like a high barrier across the country. The same is the

character of the climate both north and south. These mists keep the country moist and sustain many small streams. There is then no mystery in the prevalence of forests about the hills, plains and mountains of the coast.

Again, the *temperature* of the coast and that of the interior portions of the Western Section (west of the Cascade Range) are widely different. In the Willammet, the summers are hot as well as dry, the temperature usually varying between 68° and 90°.* On the Sacramento the heat is much more excessive,—there is a beautiful clear sky, but a parched land beneath; and the long succession of hot days, the thermometer often up to 100° F., make it a debilitating climate for a long residence, although excellent in other respects, excepting for a time in autumn when there are intermittent fevers. The rains do not set in till November or December.

On the coast at the mouth of the Columbia, the nights are cold, and the days are hardly comfortable in summer without a fire. At San Francisco, which is near the coast, the thermometer in summer according to Mr. Lyman's observations in August, 1848, was not above 68° F.; and chilly fogs were frequent, so that fires were necessary to comfort.† A degree and a quarter farther south, at Monterey, according to observations in 1845 by Mr. Talbot H. Greene, the thermometer was not above 74° in any part of summer; in August, it ranged between 42° and 73°.

Between the two extremes, the cold shores of Francisco and the hot interior plains, lies the fertile valley of St. Joseph, forty miles from the ocean, and separated from the valley of the Joaquin by a ridge two to five thousand feet high. Here the airs are mild and pleasant throughout the season: neither the chilling mists of the coast nor the parching heat of the Sacra-

* The following facts are derived from tables by John Ball, made in 1832 and 1833, at Vancouver, Oregon. (This Journal, xxviii, 9, 1835.) The hours of the observations are not given.

	Extremes at morning.	Extremes at noon.	Mean at noon.
Temp. of December, 1832,	32 and 53° F.	40 and 54	45
" January, 1833,	17 and 54 F.	28 and 58	41½
" February,	32 and 47 F.	44 and 55	48½
" March,	32 and 40	50 and 60	. . .
" April,	32 and 41	45 and 65	. . .
" May,	32 and 60	50 and 75	. . .
" June,	45 and 60	55 and 95	. . .
" July,	41 and 60	73 and 95	84½
" August,	46 and 63	69 and 93	77
" September,	43 and 60	57 and 88	71

The observations made under the direction of Capt. Wilkes, gave for July, the mean at 2 P. M. 87°, for August 86°, for September 78°. (Narrative, v, 138.)

A full Report of the Meteorological observations of the Exploring Expedition, including those made in Oregon and California, is yet to be published by Capt. Wilkes.

† This volume, page 291.

mento and Joaquin intrude; and it is this intermediate position which gives to the region its remarkable salubrity and exuberance of fertility. The mists and rains are collected by the high ridges that bound it on the east, and at the same time a shore range cuts off the cold of the coast.

The climate of the inner portion of the Western section of the territory is farther modified by the summits covered with snows that occur along the Cascade mountains of Oregon, and that constitute the lofty Sierra Nevada. They cause cool nights to follow the hot days and ameliorate the excessive heat, especially on the plains in the vicinity of the range. Within thirty miles of the Shasty Peak, we had 90° F. in the shade at noon, and 32° F. the next morning just before sunrise; and such changes happened several times along the route.

To the eastward, beyond the Cascade Range and Sierra Nevada, the country is more elevated and colder; and the climate becomes gradually more and more dry towards the summit of the Rocky Mountains, being excessive in its drought to the south about the region of the Colorado. There are at long intervals green spots that admit of cultivation by irrrigation.

Over the Great Basin, Fremont found a cool climate, though less so, for the season, notwithstanding its height, than in Eastern America. Crossing it in November, 1845, (5th to 25th), between latitudes 41° and 38°, the mean temperature at sunrise was 29°, and at sunset 40°. Excepting a snow storm between the 4th and 7th, the weather was uninterruptedly clear until the close of the year, without rain or snow. He observes also that "the winter of 1843, 1844, within the basin, was remarkable for the same open, pleasant weather, rarely interrupted by rain or snow."*

Emory, in the month of November along the Gila, had generally clear weather, with rain but twice. The temperature on Nov. 23 and 24, near the mouth of the Gila, varied from 40° to 69° F.; (40° at 6 A. M.) On the morning of the 25th, it was at 27° F.; morning of the 26th at 5 A. M. on the Jornada, 21° F., and 60° F. at 5 P. M. A desert was passed between the Rio Colorado and the mountains east of San Diego.

It has not been our purpose to present a full account of the meteorology of the region. We have cited a few facts only in illustration of the general views here presented.

The great difference between the mean temperature of the east and west coasts of America is a fact well known. Vancouver in latitude 45° 40′, has nearly the temperature of Baltimore in latitude 39° 22′, and generally, the difference corresponds to six or

* Geographical Memoir upon Upper California, p. 13.

seven degrees of latitude, being as great nearly as between the eastern and western borders of the Atlantic.

Peculiarities of climate are to be traced to the prevalent winds, the height and position of a country, and the courses and heights of its mountains. The winds from an open ocean, as has been often observed, will seldom be much colder than the temperature of the ocean itself, and this is below freezing. But winds from the land partake of the heat and cold of the land, which have a wide range. Thus in Tierra del Fuego in latitudes 52° to 55°, the temperature of winter is comparatively mild.* Again, when the winds come from over open arid land in summer, as happens at times in Eastern Australia, and often with all regions in the vicinity of deserts, there is an excessive heat in the atmosphere; or when they blow from northern territories covered with snows, as is common in winter in the northern portion of the United States, extreme cold is the necessary consequence.

In Western America the prevalent winds are from the ocean. This fact alone is a sufficient cause for the mildness of the seasons, as compared with eastern America.† But besides this, when a land breeze blows in the colder months, it comes usually from the southward and eastward and seldom from the northward or north-eastward.‡

The same facts explain the peculiar dryness of the climate in summer, and the occurrence of rains in winter. The oceanic

* Fitzroy, who spent many months of different years about Tierra del Fuego, states that in June of 1834, (corresponding to our December,) the thermometer did not sink below 38½° F., and the mean of the first twelve days was 41° F. In February of the same year, (corresponding to our August,) at Port Famine, the thermometer ranged between 47½° and 53½°. In February of 1833, at Good Success Bay, and in that vicinity, (lats. 53 to 55,) the thermometer ranged from 46½° to 51°.

† Capt. Wilkes observes on this point, "I am disposed to believe this (the heat of summer) to be owing to the prevalence of southwesterly or ocean winds."—*Narrative*, v, 139.

‡ From the table by Mr. Ball, referred to on page 390, we obtain the following facts, relating to the prevalent winds of the months of the year.

	Westerly.	E.	S.E.	S.	N.E. and N.
November, 1832, .	13 days.	9 days.	8 days.	..	..
December, . .	5	..	24	2	..
January, 1833, .	6	13	8	1	..
February, . .	12	1	7	5	2
March, . . .	25	..	4	2	..
April, . . .	22	..	2	3	..
May, ...	22	..	4	4	..
June, . . .	24	..	..	1	5
July, . . .	21	2	..	..	5
August, . .	20	1	1	..	4
September, . .	11 (variables 8 dys.	..	2	2	4
October, . .	15	5	9	..	2

East winds were observed only three times during the summer the Exploring Expedition was in Oregon. The winds were almost constant from the W.N.W. to W.S.W.

winds come to a great extent from the northwest and west. Being cooler than the land of the interior, (which is heated by the sun's direct rays above the temperature of the ocean,) they are gradually becoming warmer as they range along to the southward and eastward over the territory: and as heated air will take up more moisture than cold air, the capacity for moisture is gradually increased. The winds therefore come from the ocean with comparatively little moisture, and as they become warmer in their progress, they are continually absorbing it from every surface or object they touch, and thus parch the open lands.*

Just the reverse condition exists upon the eastern shores of our continent, where the winds blow to a great extent from a tropical direction, and coming surcharged with moisture, drop it readily against the cold hills, or wherever northerly airs are encountered.

About the hills and ridges of the interior, much moisture is condensed. For besides dews, mists form in these more elevated regions in *three* ways:—(1) either from the cooling of a moist overlying atmosphere below the dew point through the influence of the cooled land and foliage;—or by means of the winds that blow over the hills, which may either (2) condense by their coolness the moisture of the air about the heights, or (3) bring in moisture to be condensed by the cool hill-sides;—the results depending somewhat upon the time of the day and the season of the year. These regions are thus enabled to support a growth of trees, when the plains below are bare.

Along the shores, the ocean winds produce comparatively cool weather in summer, as they have not been moderated in temperature by passing over any part of the land. Within thirty miles of the sea, the lower airs that oscillate back and forth, as night and day alternate, are usually moist and favor the formation of heavy mists. The land chilled at night by winds and radiation, often chills the air above, so as to cause the moisture to become visible in mists. In the formation of these mists in other cases, the sea-breeze encounters a cold land and cold airs, and its vapors are thereby condensed; or it meets with warmer moist airs and condenses the moisture they contain. By these means, at different periods, a moist climate is produced.

Southeast and south winds usually bring clouds and rain over Western America, and these are common in the winter months. They are warm winds charged with moisture which is readily

* Mr. W. C. Redfield first applied this principle in explaining the origin of deserts; and as he has shown, it is not only sufficient, but the only one sustained by facts. For it meets the important general truth that deserts occur within the latitudes 20° to 35° north or south, and principally on the *western* side of continents, where the winds are blowing for the greater part of the year from extra-tropical latitudes, towards the tropical, and are therefore drying winds.

yielded as rain, on encountering the colder airs and colder country reached in their progress north.

The Westerly winds alluded to are well known to pertain to the great circuits of the atmospheric currents. As the trades (easterly winds) prevail over a large part of tropical latitudes, below the parallel of 25° or 30°, so westerly winds prevail in extratropical latitudes north and south of latitude 30° or 35°.* These winds are even more regular and constant in the Pacific than in the Atlantic,—both north and south of the equator; and vessels are accustomed to take advantage of them in their voyages across the ocean.

From the survey of facts which has been made, it is apparent that the prevalence of oceanic westerly winds in connection with the infrequency of northern land breezes, is the cause of the mildness, as well as dryness of the climate of Northwestern America. It has determined the distribution and limits of the forest and prairie regions, and has originated the barren semi-deserts of inner and lower California. The great Dividing Mountains of the Territory (the Cascade Range and its Southern continuation) prove a partial barrier to these ocean winds, preventing them more or less from carrying their moisture easterly and scattering too widely the scanty allowance to benefit essentially the country; they gather the vapors partly in solid snows about their heights, and partly in mists and rains, thence to impart waters to streams that flow down and irrigate the wide valleys. A region along the Pacific is thus cut off from the arid interior and rendered fertile; and its salubrity is farther enhanced by the cool airs from the mountains poured at night upon the heated plains. The long parallelism of the mountain ranges to the coast, has given great length to the rivers by forcing the waters over a large area into a few main streams that make a long and devious way to the sea, expanding thus the alluvial prairies and distributing channels of internal navigation. By such means, the Western section of the Territory is made to abound in agricultural and pastoral resources, and is supplied with extensive forests, while the region east of the Dividing Mountains is comparatively unproductive. The former may become densely populated and full of activity in all the varied pursuits of civilized life; the latter promises a support only for widely scattered herdsmen, with here and there a village or town where a large stream gives sufficient water for irrigation.

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* Mr. Wm. C. Redfield, to whom we have already referred, has given us the best exposition of this subject in his memoirs. See this Journal, xx, 50, 1831; xxv, 124, 1834; xxviii, 314, 1835; xxxiii, 61, 1838; xlv, 295, 302, 1843.

ART. XXXV.—*On Biogen, or the so-called Albumen in the Ovarian Egg.* (From a letter of E. DESOR, to Prof. C. VOGT, in Giessen. Communicated by the author for this Journal.)

LIKE many embryologists I have often had doubts concerning the real nature of the so-called albumen in the eggs of the invertebrate animals. The theory of von Baer, that in animals without oviducts, the albumen is formed in the ovary itself, did not satisfy me, from what I had seen of the metamorphoses of the immature egg. And having an opportunity during the past winter to examine a great number of invertebrate animals, I took the occasion to investigate more closely this supposed albumen.

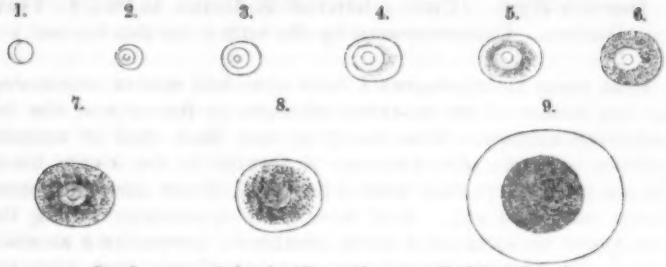
The following facts in their general outline were observed in the eggs of various animals, particularly Mollusks and Worms, but most thoroughly in the ovarian eggs of Ascidiæ.

On the 15th of May of this year, I first had the opportunity of examining the ovary of *Ascidia rustica* from Boston harbor. I extracted the ovary of a full-grown animal, and on bringing it under the microscope, I found it filled with vesicles of very various size and appearance; some very small and transparent; others somewhat larger, with granular contents; and others again, the largest of all, having in the middle an opaque ball surrounded by a transparent liquid. With a stronger magnifying power (100 diameters) I discovered yet smaller eggs looking not larger than a pin's head, and measuring less than $\frac{1}{18}$ of a millimetre, (fig. 1.) whilst others had the apparent size of a pigeon's egg, (fig. 9.) Between these extremes I found all intermediate sizes, as shown in the following drawings, figures 1 to 9, and satisfied myself that they were all eggs. The smallest consisted apparently of a simple vesicle, (fig. 1.) In somewhat larger ones, two outlines were visible, an outer one, the vitelline membrane, and an inner, the germinative vesicle. Within this I saw besides a smaller vesicle, the germinative dot, (fig. 2.)

As usual, the germinative vesicle in the smallest egg is very large in comparison with the enclosing membrane (the vitelline membrane.) By degrees the latter enlarges, whilst the former seems to remain stationary.

Before the ovulum has increased to double the size of the germinative vesicle, it is perfectly transparent, (fig. 1–3.) In the egg of fig. 4, the liquid began to be somewhat turbid, and the germinative vesicle seemed as if surrounded by a light cloud. In somewhat larger eggs (fig. 5,) I found the cloud more distinct, particularly about the germinative vesicle; and with an increased power (500 diameters) I could already distinguish very minute granules in it. In the egg of fig. 6, these granules were distinct

vesicles. The whole sphere, except the germinative vesicle, was filled with them. In that of fig. 7, I found the yolk-granules or



Ovarian eggs of the Ascidia rustica, magnified 100 times.*

vesicles much crowded, particularly in the middle, so that it was with difficulty that I could distinguish the outlines of the germinative vesicle. The granules had not only increased in number, but it was also evident that a condensation had taken place in them towards the middle, for it was only towards the edge that the mass appeared loose. In the egg of fig. 8, the condensation had proceeded further. The germinative vesicle was no longer visible, except when I compressed the egg. On the other hand the vitelline mass seemed to withdraw itself more and more from the edges, and already a wide border had appeared between the outer membrane and the edge of the yolk. Finally I observed in the ovary, several eggs of considerable size (fig. 9,) in which the yolk formed a compact ball, well defined on all sides, and surrounded by the transparent liquid as by an albumen, precisely as it is in the eggs after they are laid.†

From these observations it clearly appears, that this clear liquid surrounding the yolk is quite different from the albumen of the eggs of higher animals. Far from being added from without, it seems to me on the contrary to be the fundamental substance, the mother-liquid, from which the yolk is, as it were, precipitated. I

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* Fig. 1. Very small egg in which no germinative dot could be seen, but only the germinative vesicle.

Fig. 2. A somewhat larger egg, with a small germinative dot.

Fig. 3. A still larger egg, but yet entirely transparent.

Fig. 4. A light cloud is seen surrounding the germinative vesicle.

Fig. 5. The cloud has spread and is more distinct, with a granular appearance.

Fig. 6. The cloud fills the whole egg and appears distinctly as granular yolk substance.

Fig. 7. The granular yolk substance is denser around the germinative vesicle.

Fig. 8. The granular yolk substance begins to recede from the margin. The germinative vesicle has become quite indistinct.

Fig. 9. The yolk substance is condensed into a regular ball surrounded by a transparent liquid, (the biogen.) The germinative vesicle is hidden.

† Occasionally no formation of yolk takes place, and such eggs have been erroneously considered as empty shells. The biogen is present in these also, only unproductive. These eggs (the supposed empty shells) occur particularly in the extremities of the strings of eggs in Eolis, Doris, Acteon, &c.

shall therefore designate it by another name, and propose to call it from its physiological significance, *Biogen*, or the biogen liquid.

Now if the yolk is really the product of the biogen liquid, this explains the absence of a separate covering or membrane around it. Just as in the ovarian egg of the hen or the frog, so in the ovarian egg of the Ascidia and of all Mollusks, there is but one membrane. The second, or shell membrane, is not acquired in these higher animals before the passage of the egg through the oviduct. But as nothing of the kind takes place in Mollusks, it is natural that their eggs, even *after their expulsion from the ovary*, should have only a single membrane. It is only because the transformation of the immature into the mature egg was overlooked, that the error has been committed of considering the outer membrane of fig. 9, as different from that of figs. 6 and 7. In fact however, there is no difference between them except that in fig. 9, the yolk-substance has retreated from the edges and been concentrated into a compact ball. The biogen fluid itself undergoes essential modifications in the course of the development. At first it is tolerably compact, and in many ovarian eggs even gelatinous. By degrees it becomes thinner and at last quite fluid, so that it seems to afford no important hindrance to the revolving embryo.

How far this mode of formation of the yolk out of the biogen liquid is applicable to the eggs of vertebrate animals, must be learned from future observations. Something of the kind is certainly to be seen in the eggs of Mammalia. According to Bischoff's investigations, the yolk in the mature egg of the rabbit fills the whole zone. Some days later, however, after it has left the ovary, there appears between the zone and the yolk a clear space, filled with a transparent fluid.* This fluid, to which Bischoff particularly calls attention, has, we believe, never been satisfactorily explained. For it is hardly to be supposed that it is water, received by means of endosmosis, as has been supposed in the case of the eggs of fishes; for, from whence should the water come? But on the supposition that the yolk condenses, the matter is quite simple. The clear fluid is in that case nothing else than a part of the biogen liquid, which has been separated by the condensation of the yolk.

If this explanation is well founded, there must be a time when the mammalian egg also is transparent, that is, before the separation of the yolk-granules or vesicles has begun. And indeed I should not be astonished if the vesicles with inner cells, which Bischoff figures and describes as probably immature eggs, should prove to be the analogue of our Ascidian eggs, as represented in figs. 1–5.

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* Bischoff, Das Kaninchen-Ei. Tab. I.

As to the relation of the biogen liquid to the germinative vesicle, and which of them first appears, I could not satisfy myself neither in the eggs of Ascidia nor in those of the other Mollusks and Worms which I have hitherto examined. Although in some instances I thought I had found an ovulum consisting of a simple cell, yet on examination with a higher power, I commonly detected the enclosed germinative vesicle. My friend, Professor Gilman of New York, who has made extensive investigations of the ovarian egg of fishes, maintains on the contrary, that in the ovarian egg of the perch, the outer (yolk) membrane appears first, and that even the separation of the yolk, under the form of a slight cloud, *precedes* the formation of the germinative vesicle.*

It is doubtful therefore, whether a law is discoverable which shall be applicable in this respect to the whole animal kingdom. Meanwhile the following facts observed in a marine Worm, (Sigalion,) may not be without interest.

Last spring I had several times an opportunity of examining ovarian eggs of the Sigalion. I found them, as usual in Annelids, collected on each side of the intestinal canal. The eggs were nearly mature, and the yolk opaque. But I was struck by a reddish spot in each egg, except the very smallest; (figs. 10–14; the

Ovarian eggs of the Sigalion, magnified 40 times.†

red spot is here distinguished by lined shading). What was my astonishment on bringing them under the compressorium, to see that this red spot was enclosed in a transparent vesicle; in other words, that it was the germinative dot (*vesicula Wagneri*)! Besides this, I observed that in many eggs, particularly the larger ones, the red germinative dot itself enclosed a clear transparent vesicle, as I had seen it in the eggs of Actinia, and as Valentin has observed it in the ovarian egg of the Echini, and which I for that reason propose to call *Vesicula Valentini*.

Whatever may be the office assigned to each of these parts of the egg, thus much clearly follows from this observation, that from the beginning there must be a definite and essential distinction in their composition. And it seems to me that this decided

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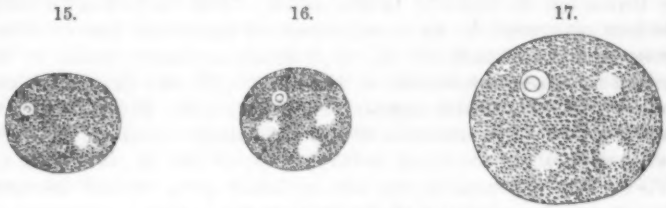
* He also maintains the existence of a double covering in the egg of fishes,—a yolk-membrane and a shell-membrane, neither of them destitute of structure.

† Fig. 10. A very small egg without germinative dot.
Fig. 11. The red germinative dot appears.
Fig. 12. The red germinative dot has grown larger.
Fig. 13. There is seen in the germinative dot a small clear cell, (Vesicula Valentini.)
Fig. 14. The vesicula Valentini is very distinct.

distinction contradicts the supposition that the so-called clear spots which so generally appear in the yolk in almost all animals, particularly at the commencement of the fissuration, are merely the remains of the germinative vesicle. Still less can they be traced to the germinative dot, since it is well known that they are always clear and transparent, and as far as I know, no one has found red spots in the spheres produced by fissuration.

This supposition, that the clear spots are derived from the remains of the germinative vesicle, is moreover opposed by the following fact, which was observed by me and several of my friends in Boston, in the ovarian eggs of Sabella, viz. that the clear spots *appear before the disappearance of the germinative vesicle*, as is seen in figs. 15–17. The spots were very distinct,



Ovarian eggs of Sabella, magnified 40 times.*

and had the characteristic oily appearance which has induced several observers to designate them by the name of *oil-drops*. In one ovulum we saw no less than three such spots, besides the germinative vesicle, (fig. 16.) With a higher power and a slight pressure they kept their relative positions, and a careful comparison of their outlines with that of the germinative vesicle, convinced me that they were not surrounded by a membrane.

ART. XXXVI.—*On some principles to be considered in Chemical Classifications;* by T. S. HUNT, Chemist to the Geological Survey of Canada.

Read before the American Association for the Promotion of Science, at the annual meeting, held at Philadelphia, Sept. 20th, 1848.

THE progress of chemical investigation has made known a vast number of substances under the different names of "products of substitution," copulates, ethers and amids, which may be generally described as formed by the combination of two other compounds and the elimination of water or hydrochloric acid. In

* Fig. 15. Egg showing the germinative vesicle and one clear spot.
Fig. 16. Egg showing the germinative vesicle and three clear spots.
Fig. 17. The same egg compressed.

searching for some principle which shall enable us to arrange this large class of products, the first question to be settled is, to which of the parent bodies does their type pertain? For example, is an ether to be regarded as a species derived from the acid or the alcohol, by the mutual action of which it is formed? A correct answer to this question is necessary before we can arrive at a right understanding of the laws of combination, and the principles upon which these compound, are to be classified.

The ingenious but partial views of the two great schools of the day, those of Liebig on the one hand, and those of Gerhardt and Laurent on the other, have failed to give a satisfactory answer, or to remove the many difficulties that environ the subject. There seems to be a portion of truth in both systems which each is unwilling to concede to the other. The two systems may be best compared by an examination of some well known compounds. Oxalic acid ($C_2 H_2 O_4$) which is bibasic, yields by its action upon one equivalent of alcohol ($C_2 H_6 O$), the oxalovinic acid $C_4 H_6 O_4$, which equals $(C_2 H_2 O_4 + C_2 H_6 O) - H_2 O$; while with two equivalents of alcohol, oxalic ether $C_6 H_{10} O_4$ is formed, which is equal to $(C_2 H_2 O_4 + 2C_2 H_6 O) - 2H_2 O$. These two compounds are distinguished from several isomeric bodies by the results of their decomposition; in the presence of alkalies they can resume the elements of water and regenerate alcohol and an oxalate;—a reaction which shows that in these bodies, there is a constitutional or functional relation to oxalic acid and alcohol.

It now becomes desirable to define the nature of that relation so that it may be represented by formulas. Mr. Gerhardt, keeping in view the electro-chemical ideas of Berzelius, supposes the acid to act upon the alcohol or rather upon its hydrogen by virtue of its oxygen, so that the various acids in relation to alcohols, ammonia and hydrocarbons, may be regarded as electro-negative, while the latter are electro-positive.* According to this hypothesis, in the formation of oxalovinic acid, where $H_2 O$ has been eliminated, the acid has lost O while the alcohol has lost H_2, so that the compound is to be regarded as an alcohol in which oxalic acid *minus* O replaces H_2; or rather making the electro-negative the generic type, oxalic acid where alcohol minus H_2 replaces oxygen. In the same manner, oxalic ether is the acid in which a second equivalent of oxygen is replaced by the same elements. Representing $C_2 H_6 O - H_2$ by Et:—

$$\text{Oxalovinic acid} = C_2 H_2 (O_2 Et)$$
$$\text{Oxalic ether} = C_2 H_2 (O_2 Et_2)$$

* Précis, tom. ii, p. 495.

The same view is extended to the two oxalic amids, which are the acid in which one and two equivalents of oxygen are replaced by the residue $NH_2 - H_2$ represented by *Am*, which is the equivalent of O; in the anilides $C_6 H_7 N - H_2 = An$, has the same power. A difficulty however, arises in extending this view of the constitution of ethers, for we find acids which contain no oxygen and yet act with alcohol in the same manner as an oxacid. Hydrochloric acid, Cl H, forms with alcohol, an ether with the elimination of an atom of water, precisely as acetic or nitric monobasic oxygen acids, would do. Here the electro-negative theory, as just interpreted, is at fault, and hydrochloric ether although resembling in all respects the ethers of the oxygen acids is separated from the class and made a chlorinized species of the carbo-hydrogen acetene $C_2 H_6$.

M. Gerhardt has extended this idea to all the copulate bodies derived from the action of nitric and sulphuric acids upon hydrocarbons, organic acids and neutral bodies, and in expressing by formulas their composition, admits that $SH_2 O_4 - O = Su$ and $NH O_3 - O_2 = Ni$, are to be considered as equivalent to H_2, while $C_2 H_6 O - H_2 = Et$, $NH_3 - H_2 = Am$, and $C_6 H_6 - H_2 = Bz$, are equivalent to O.

At the same time he announces the following law as regulating the basic power of all these copulate compounds, "the basicity or capacity of saturation in a coupled body is always less by unity than the sum of the basicities of the two bodies thus united." Expressing by S the basic capacity of the coupled body, and by Σ the sum of the basicities of its components, we have $S = \Sigma - 1$.*

M. Liebig on the other hand has seen the realization of the electro-chemical theory of Berzelius, in the saline constitution, which agreeably to the dualistic notions of the day, includes the idea of a base and an acid or a halogen body and a metal, (the two being united in Liebig's new theory of salt-radicals.) He sees in the ethers, compounds analogous to the salts, and in the elements of alcohol *minus* HO, something which in its chemical relations, is similar to a metal and like it is capable of replacing the equivalent of hydrogen upon which the basic power of acids depends. Some of his School, however, still clinging to the idea which recognizes combined water in the acids, choose to represent the ethers as compounds of the so-called anhydrous acids with the oxyd of the quasi-metal, but this view is still reducible to the principle which is more easily expressed in accordance with the salt radical theory. When nitric acid $NH O_3$ acts upon alcohol, the elements of an equivalent of water are set free, and nitric ether $C_2 H_5 NO_3$ is formed, which is regarded as nitric acid in which

* Précis de Chemie Organique, tom. i, p. 102.

C_2H_5 (C_4H_5 in his notation) = Ae replaces H; nitrate of ethyle N Ae O_3 corresponding to nitrate of silver N Ag O_3. Hydrochloric ether and the compounds allied to it, may by this hypothesis be brought into the same class and assigned the place to which by their reactions they are justly entitled; they become chlorid, bromid and iodid of ethyle.

This view removes a difficulty unexplained by the theory of Gerhardt; the ethers proper are quite neutral, the saline capacity of the acid having been satisfied by combination with the elements of alcohol. It is not easy to understand how a replacement of an equivalent of the oxygen by the organic elements, could effect this, for in many instances the oxygen of a compound may be wholly or in part replaced by sulphur or other elements without affecting its basic relations; but on this view the hydrogen of the acid, upon which its capacity of saturation depends, is removed in the elimination of the equivalent of water. Bibasic acids like the oxalic should then yield monobasic compounds with *one*, and neutral compounds with *two*, equivalents of alcohol; in accordance with this, the oxalovinic acid is monobasic, and the oxalic ethers neutral.

The amids are derived from ammoniacal salts which contain the elements of the acids *plus* NH_3, and the composition of the amid of a monobasic acid is that of the ammonia salt, *minus* H_2O. Acetic acid being $C_2H_4O_2$ and acetate of ammonia $C_2H_7NO_2$ ($=C_2(H_3NH_4))O_2$, acetamid will be C_2H_5NO; this compound is capable of regenerating ammonia and the acid, by assimilating H_2O; it is neutral, and in its reactions so much allied to an ether that the resemblance is at once apparent; while it is equally clear that it should be referred to the acetic type. But when the acid reacts with the elimination of an atom of water, upon a body which contains no oxygen, the equivalent of this element must evidently be derived from the acid itself, and hence we cannot by any ordinary formula represent acetamid as a direct derivation of the acid; for while if we make

acetic acid, = acetic ether

$$C_2H_3H'O_2 = C_4H_8O_2$$
$$H' = C_2H_5$$

we find that if

acetic acid = acetamid

$$C_2H_3H'O_2 = C_2H_5NO$$
$$H' = H_2N - O.$$

In other words, if we would assimilate the amids to the ethers upon M. Liebig's plan, we must have $H_2N - O$, replacing the equivalent of hydrogen or ethyle. He, however, disregarding the analogies between them, is obliged in accordance with his views of organic radicals to regard this and similar compounds as

containing certain hypothetical bodies, which differ from the acids by the elements HO combined with amidogen NH_2; thus benzamid is the amidid of benzoyle and acetamid will be the amidid of the deutoxyd of acetyle, which is only assimilated to acetic acid through the imaginary radical acetyle.

M. Dumas has recently observed that acetate of ammonia by the action of anhydrous phosphoric acid, loses the elements of two atoms of water and yields a new compound which has been called acetonitrile, and which may be directly derived from acetamid by the loss of H_2O; its formula is consequently C_2H_3N. The subsequent researches of Dumas, Malaguti and Schlieper, and the previous ones of Fehling, have shown that a large number of acids yield compounds similar to acetonitrile. These bodies which have received the generic appellation of nitriles, like the corresponding amids, regenerate ammonia and the parent acid by the action of alkalies and acids. If in accordance with this reaction, we attempt to refer acetonitrile to acetic acid, we have $H'=N-O_2$; or if we adopt M. Liebig's view, it is a nitruret of acetyle; and while according to M. Gerhardt, acetamid may be represented as acetic acid in which NH replaces O, in acetonitrile the equivalent of O_2 is N – H. The author of the Prècis hence regards this and similar compounds as amids of the anhydrids of the acids and designates them *anhydrid amids*.

M. Fehling in studying the action of potassium upon succinic ether, has made known an anhydrid ether, comparable with the anhydrid amids. His alcosuccinal ($C_6H_8O_3$) is succino-vinic acid minus H_2O, and contains the elements of succinic acid and one equivalent of alcohol *minus* $2H_2O$. It will probably be a monobasic acid, since succinidam, the corresponding amid, which is the anhydrid of succinamic (homologue of oxamic) acid, is capable of exchanging an equivalent of its water for lead or barium. It is impossible, according to either of the received hypotheses, to represent this as an ether of succinic acid; agreeably to the received views it must be regarded as the ether of succinid, a substance which exhibits none of the characters of an acid.

The theory of M. Liebig which explains so satisfactorily the formation of ordinary ethers, is no longer eligible when applied to the amids; in fact the formation of ammoniacal salts by the action of acids upon the hypothetical oxyd of ammonium, is the only reaction which in his view can be regarded as a parallel to the formation of ethers. At the same time the existence of such bodies as the amethanes of Dumas, which by the assimilation of two equivalents of water are converted into a bibasic acid with one equivalent of ammonia and one of alcohol, besides the analogies already noticed, point out too plainly to be mistaken, a relation between ethers and amids which his system does not express. We are obliged to admit that as one is directly derived from alcohol and an acid, by the abstraction of H_2O, the other contains

ammonia and the acid *minus* the same elements; and if we would be consistent with the view which makes C_2H_5 (C_4H_5 Liebig), and NH_4, radicals equivalent to H, we must equally admit H_2N-O and C_2H_5-O to the same rank, for they are as really equivalents of H the atom of hydrogen.

Thus do the compound radicals come to be mere mathematical expressions; the only value which can ever be attached to them is that which belongs to an irreducible expression in an algebraic formula. Understood in this way as representing the equivalent of certain other elements, they may be conveniently introduced in our chemical formulas. Herein lies the truth of M. Liebig's celebrated hypothesis; had he seen the necessity of such substitutes for O as $\frac{N-H}{2}$ at the same time with NH_2, he would have never given the latter a rank which could imply its existence even in combination. Although the elements which in an ammoniacal salt replace H, are represented by NH_4, there is no more reason for supposing a separate existence to the elements denoted by the expression than to the kindred formulas NH_2-O and $N-O_2$, for the conception of the one violating, as it does, the laws of molecular constitution, is no less monstrous than the other.

To represent then, the *etherids* and *amids* of oxalic acid, in accordance with the compound radical theory, we have

1. Oxalic acid, $C_2(H_2)O_4$.
2. Oxalovinic acid, $C_2(H(C_2H_5))O_4$.
3. Oxalic ether, $C_2(C_2H_5)_2O_4$.
4. Oxamic acid, $C_2(H(NH_2-O)O_4$.
5. Oxamid, $C_2(NH_2-O)_2O_4$.
6. Oxamethane, $C_2((C_2H_5)(NH_2-O))O_4$.

The introduction of Liebig's system seems to have been almost a necessary event in the progress of chemical philosophy; it was a view which, as discovery advanced, very naturally presented itself to minds impressed with the notion of dualism, inculcated as one of the first principles of the science. A saline substance is regarded as a binary combination of an oxyd and an acid, or a metal and a radical, in which these two actually exist as such, and the analogies between compounds, like chlorid of potassium and salammoniac, are such that if we regard one as a binary combination of Na with Cl, the other must be viewed as formed by the union of NH_4 with Cl. It has however been shown that the elements thus replacing hydrogen or a metal, have not only not a necessary, but sometimes not even a possible, existence, and that all we can infer from such substitutions, is that those expressions represent an equivalent amount of the forces which are necessary to preserve the integrity of the complex molecule. Chlorine, as known to us, does not exist in common salt, for from the combining volume of the gas, it appears that in

its free state it is a combination of two atoms, and is really Cl_2; the same view extends to the metals.

It has been shown that the hypothesis of M. Gerhardt, which supposes that in ethers and amids, alcohol and ammonia *minus* H_2, replace an equivalent of oxygen, is objectionable because it does not account for the changes in the basic relations of the acids, and leaves unexplained the reason of his law of $S = x - 1$. We are thus led to recognize the view of Liebig, *apart from his ideas of dualism, and his theory of compound radicals*, as the one fundamentally true, and it remains to give it a general expression which shall include all the reactions of the class which we are now reviewing. This, we shall endeavor to show, may be accomplished by an application of the great principles which M. Gerhardt has defined in his Prècis, although still misled by the electro-chemical philosophy, he seems to have erred in their application.

The class of compounds which we are considering in the present essay, may be viewed as products formed by an apomorphosis which generally consists in the separation of the elements of water; and this class will be found to include the greater part of all chemical compounds. M. Gerhardt observes that, "of 1,000 reactions taken at hazard, 990 of them will consist in the elimination of some substance from the organic matters, and this something is always water, hydrochloric acid, or some other mineral substance with a composition equally simple."*

In these reactions the saline capacity of one of the bodies is always wholly or in part neutralized; in the ethers by the replacement of the hydrogen by C_2H_5, and in the amids by the substitution of $NH_2 - O$ for that element. These, as M. Gerhardt remarks, are related to the ammoniacal salts, in which NH_4 replaces H, as anhydrids are to acids; the process may proceed still farther under the influence of heat or a dehydrating agent, and the monobasic salt eliminate a second equivalent of water, forming a nitrile. This is due to a farther reaction between the acid and the replacing elements, resulting like the previous one, in the separation of H_2O, and a more intimate union than before, and is analogous to the change effected by heat upon tartar emetic and similar salts. These compounds, like simple anhydrids, must all be regarded as pertaining to the acid from which they are derived, and we are hence led to the enunciation of the following principle which applies to all coupled bodies whatsoever.

In all compounds produced by a reaction which results in the elimination of one or more equivalents of water or hydrochloric acid, (or any body referable to the type H_2O or H_2,) the parent body is that which loses saline hydrogen.

(To be continued.)

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* Précis, tom. ii, p. 495.

ART. XXXVII.—*New and Rare Plants, chiefly of the Carolinas;* by M. A. CURTIS.

MALVA TRIANGULATA, *Leavenworth.*—M. Houghtonii, *Torr. & Gray!* This species was detected some years since on the Catawba in Lincoln Co., N. Car., and sent to me by Dr. C. L. Hunter.

PTELEA MOLLIS, *n. sp.*—P. trifoliata, β. mollis, *Torr. & Gray?* I. 680. Lateral leaflets oval, the terminal obovate, with an abrupt acute point, the underside with the petioles, panicles and young branches, clothed with a soft whitish silky villus; cymes compact, with short branches; style long; filaments equalling the anthers.—Wilmington, N. Car. Also, Newbern, N. C.; *George Wilson, Esq.:* the low country of S. Car.; *Rev. T. J. Young.*

The style in this species is twice as long as in P. trifoliata, while the filaments are only about one third or one fourth as long. The mature leaves are much more rigid. With the exception of the style, this plant is much smaller in all its parts, and the sepals very deciduous. Flowers tetrandrous.

GALACTIA SESSILIFLORA, *Torr. & Gray!*—This species extends along the interior portion of the sandy region of S. Car., to Cumberland Co. in N. Carolina.

PETALOSTEMON CORYMBOSUM, *Michx.* var. β.—Folioles 5–7 pairs narrowly oblong linear, commonly emarginate. A very marked variety. Low country of S. Car.; *Rev. T. J. Young.*

BAPTISIA SERENAE, *n. sp.*—Very smooth, branching; leaves oblong-obovate, cuneate, petioled; flowers (yellow) in a long loose central raceme and in short racemes terminating the branches; pedicels longer than the calyx in fruit; segments of the calyx villous on the inside; legume oblong inflated, the stipe longer than the calyx. Society Hill, S. Car. Flowers May, June.

Diffusely branched, 1–2 feet high, partaking somewhat of the habit of both B. alba and B. tinctoria, its period of flowering being between theirs. It differs from the latter in the characters given above and in not turning black in drying:—from B. Lecontei in its smoothness, the absence of persistent bracts, the shape of the legume, &c. Folioles about an inch long,—legume, without the stipe, about 8 lines.

ALCHEMILLA ARVENSIS, *Scop.*—Common on grass-plats along the Pamlico in Beaufort Co., and around Oxford, N. Car. Evidently introduced.

DIERVILLA SESSILIFOLIA, *Buckley!*—Yenah Mt., Georgia. *H. W. Ravenel.*

LIATRIS PILOSA, *Willd.* (Torr. & Gray!)—Henderson Co., N. Car.

L. PAUCIFLORA, *Pursh.*—I have no doubt that this is a branched state of L. secunda, probably caused by some injury to the summit of the stem. The allied species are not unfrequently met with in a similar condition. There is no essential difference in the descriptions of L. secunda and pauciflora, if we exclude the pseudo-paniculate character of the latter.

COREOPSIS DISCOIDEA, *Torr. & Gray.*—Not uncommon in the low country of N. and S. Carolina.

BALDWINIA UNIFLORA, *Nutt.*, β PURPUREA.—Disc flowers and summits of the interior scales of the involucre dark purple. Stem 2–2½ feet high; lower leaves 3–4 inches long, with a long tapering base. Flowers 1½–2 inches in diameter.—Springy ground near Society Hill, S. Car. Sept.

MARSHALLIA LANCEOLATA, *Pursh.* β PLATYPHYLLA.—Radical leaves broadly spatulate or oblanceolate, those of the stem becoming oblong, lanceolate, or lance-oblong, amplexicaul. Radical leaves 5–6 inches in length, with long slender bases, the cauline with gradually shorter bases, the upper sessile. Stem leafy to near half its height. This form has a strong resemblance to M. latifolia.—Middle country of N. Carolina. I have collected a very similar form, but with narrower leaves, near Augusta, Georgia.

PHYSALIS MARITIMA, *n. sp.*—Softly villous and generally hoary, erect or decumbent, dichotomous. Leaves oval-oblong or oval, entire, petioled, often in pairs, acute at base, the summit obtuse. Flowers (yellow) on slender nodding pedicels. Fruiting calyx inflated, large, ovate, smoothish, enclosing the berry.—Sandy sea-shore of N. Car., and occasionally a few miles in the interior. Pedicels an inch long, equalling the petioles. Flowers through the summer. This can hardly be P. pubescens, *Pursh*, to which Gray & Engelmann have doubtfully referred it in PLANTAE LINDHEIMERIANAE.

ASCLEPIAS ACERATOIDES, *n. sp.*—Stem low, erect, tementose pubescent; leaves coarse and rather rigid, opposite, short petioled, mucronate, somewhat whitish tomentose when young especially beneath, acute at base, oval, oblong, and elliptic-oblong, obtuse or with a short acumination. Umbels numerous, sublateral, subsessile, loosely few flowered. Pedicels long, (1 inch,) pubescent. Flowers large and greenish. Calyx segments linear-lanceolate, pubescent, nearly half the length of the corol. Divisions of the corol ovate, obtuse, pubescent, longer than the crown. Hoods equalling the gynostegium, obliquely truncate outwards, the points obtuse; horn adnate to the hood to its summit, triangular falcate, compressed, slightly exsert, and, like the interior of the hood, minutely pubescent.

Three to twelve inches high, beginning to blossom at a small height. Umbels at first sessile, then sometimes acquiring a short

peduncle, alternating on different sides of the stem from the second or third pair of leaves to the summit. Follicle ——?—Sandy pine woods of Cumberland Co., N. Car., west of the Cape Fear; also, Society Hill, S. C., where it was detected by my young friend, *Miss Serena Williams.* Flowers May, June. Has very much the aspect of Acerates, and, like A. viridiflora, varies exceedingly in the form of the leaves.

Fraxinus platycarpa, *Michx.* β. pubescens.—Young branches, petioles and underside of folioles, softly tomentose.

F. platycarpa, *Michx.* γ. oblanceolata.—Glabrous. Samaras oblanceolate.—For these two forms of F. platycarpa I am indebted to my generous correspondent, Mr. Ravenel, who sent them from the region of the Santee Canal. The species can hardly be confounded with any other, though apparently subject, as are probably the other species, to considerable variation. These varieties, like the more common form, frequently have the samaras three winged. The calycle is not noticed by Michaux either in his description or figure, but it is as conspicuous as in any other of our species.

Quercus Georgiana, *n. sp.*—Dwarf. Leaves small, petioled, very smooth, somewhat obovate in outline, cuneate and often unequal at base, 3- mostly 5-lobed, the lobes triangular lanceolate, acute, mostly entire. Cup subpeduncled, saucer-shaped, the scales very smooth and closely appressed, margin thin, enclosing about one-third of the oval-globose acorn.

"Growing in clusters like Castanea pumila, 6–8 feet high, and bearing abundantly," very smooth. Leaves, including the petiole, 3–4 inches long, smooth and shining, the underside a little paler. A small villous tuft is found in the axial of one or two of the largest veins beneath. Petiole ½–¾ inch long. Sinus of the leaf rounded, extending about ⅔ the way to the midrib. Acorns ½ inch long, subglobose, marked longitudinally with pale lines. —This species is nearest allied to Q. palustris, but differs in its small size, smaller and differently shaped leaves. In the outline of the leaves and in the fruit, it has some resemblance to Q. ilicifolia; but the leaves are smooth, much larger and differently cut. fruit smaller and the cup less top shaped.—Stone Mt., Georgia. *H. W. Ravenel, Esq.*

Cyperus Iria, *Linn.*—Santee Canal, S. Car., *Mr. Ravenel.* —This interesting addition to our Flora I had taken for a new species and intended dedicating it to its discoverer, but Dr. Torrey, on the authority of a specimen from Nees, refers it as above. It was before known as a native only of the East Indies, China, and the Philippines. In the florets it has a remarkable similarity with C. flavicomus, but in the character of the inflorescence and in the seed it is very distinct.

ELEOCHARIS ALBIDA, *Torr.*—Sullivan's Island, S. C., *Mr. Ravenel.*

RHYNCHOSPORA PALLIDA, *n. sp.*—Culm rigid, acutely 3-angled, leafy, glaucous green, angles scabrous towards the summit. Leaves erect, carinate, ciliate-serrulate. Panicle terminal, capitate, compact, two of the bracteal leaves a little longer than the head. Spikelets very pale ferruginous, lanceolate, 1 flowered, 2–3 outer glumes shorter, ovate or lance-ovate, mucronate, the remaining two lanceolate, acute. Achenia obovate, smooth, compressed, reddish-brown with a paler disc, under a strong lens longitudinally striulate. Tubercle very short, depressed, apiculate. Setæ 3, $\frac{1}{2}$ the length of the achenium. Stam. 3. Style 2 cleft. —Wilmington, N. Car. June.

Culm 12–20 inches high. Achenium 1 line long. Has something of the aspect of the next species, but is stouter, with the panicles more compact and the glumes paler.

R. CHAPMANII, *n. sp.*—Densely cæspitose. Culms slender, obtusely 3-angled, striate, leafy, smooth. Radical leaves plane, the cauline filiform, short. Corymbs fasciculate, terminal, small, each of the divisions with a setaceous bract. Spikelets pale ferruginous, lanceolate, 1 flowered; glumes mucronate. Achenium oval and elliptic, compressed, pale or slightly ferruginous with a glassy disc on each side. Tubercle triangular, compressed, confluent, broad at base, $\frac{1}{4}$ the length of the achenium. Setæ 0! Stam. 2. Style long, 2 cleft.—Wilmington, N. C.—Aug. Sept.

Culm 12–20 inches high, nearly round. Achenium $\frac{3}{4}$ of a line long. Has some resemblance to R. alba. I have received this from the Santee (Ravenel); and also from Dr. Chapman of Florida, under the MSS. name of R. Grayana. I learn from my excellent friend Mr. Carey, that it is also R. conferta, *Chapm. mss.* As I have distinguished the plant for more than fifteen years, I trust the Doctor will allow me to dedicate it to one who is worthy of more honor than I can confer.

R. DIVERGENS, *Chapm. mss.*—Culm filiform, glabrous, leafy. Leaves distant, setaceous, the margins serrulate toward the summit. Panicles axillary and terminal, corymbose, small, loose and spreading, the lateral ones pedunculate. Spikelets pedicellate, small, ovoid, acute, pale chestnut, florets all fertile. Achenium obovate, biconvex, very minutely striulate longitudinally or cancellate, pale or becoming a little dusky. Tubercle small, white, constricted at base. Style long deeply cleft. Stam. 1! Setæ 0!

Culm 6–12 in. high, slender. Leaves 2–4 in. long, involute. Axillary panicle one, distant. Achenium very small, $\frac{2}{3}$ of a line long. Resembles R. rariflora at first sight, but has the closest affinity with R. pusilla, *Chapm. mss.*, from which it differs in several particulars, especially in the achenium which is not rugu-

lose. They are apparently similar to R. polyphylla, *Vahl.* (MITROSPORA, *Nees.*)

This plant was sent me a year or two since from the Santee by Mr. Ravenel. I am indebted to Mr. Carey for the MSS. name of Dr. Chapman, which I have adopted instead of the one I had intended, (R. RAVENELII,) and under which I have distributed it.

The last two species, with R. pusilla, are peculiar among the North American species in the absence of hypogynous bristles; but they differ so much in habit that they can hardly be arranged together with reference only to this circumstance. R. divergens appears to be uniformly *monandrous.*

CAREX GLAUCESCENS, *Ell.* γ. POLYSTACHYA.—Spikes 8–12, small, nodding, mostly staminate at the summit.—Society Hill, S. Car., by the margins of ponds. This, like var. androgyna, (described in vol. xliv of this Journal,) is an autumnal variety, but much smaller and less showy than the other forms, and apparently produced by having been cropped early in the season by cattle.

C. ÆSTIVALIS, M. A. C.—In a late examination of the Herbarium of Mr. Durand of Philadelphia, I found that I had been anticipated by Schweinitz in the discovery of this and the following species. To this he had given the *mss.* name of C. DARLINGTONII, which I regret it should not have borne, in honor of the excellent botanist for whom it was named.

C. MITCHELLIANA, M. A. C.—This was also indicated by Schweinitz as new, but not named. Both of them were probably collected in the western part of N. Carolina.

C. STYLOFLEXA, *Buckley!*—Lower and middle region of N. Car., quite common. I have it also from Louisiana and Florida, and I think the same was gathered by Richardson in British America. It is to me a doubtful species.

C. TORTA, *Boott.*—Mountains of N. Carolina.

C. FLACCA, *Schreb.*—Raleigh, N. Car. Also in Alabama!

POLYPOGON MONSPELIENSE, *Desf.* Phleum pratense, *Ell.!*—Sullivan's Island, S. C.! *Dr. Bachman, Mr. Ravenel,* and on the coast of N. Car. as far north at least as Ocracoke Inlet!

PANICUM CARINATUM, *Torr.!* in Curt. Enum. Pl. Wilm.—P. digitarioides, *Carpenter!* Synops.—The following, derived from an examination of fresh specimens, is a more full account of this species than that in Boston Journ. of Nat. Hist., vol. i, 137. —Culm 3–4 ft. high, stout but rather flaccid, smooth, striate, hollow. Submersed nodes radiculate. Submerged sheaths leafless, loose, shorter than the nodes, the upper sheaths longer. Ligule a fimbriate margin. Leaves 6–8 in. long, 5–6 lines wide, rather

thick, smooth except on the margins near the summit, gradually acuminate, striate, the midrib vanishing about 2 in. from the base, imperceptible on the upper surface. Panicle closely appressed, branches alternate, angled, smooth, the lowest distant, 2 in. long, becoming gradually shorter and crowded at the summit. Flowers (5–7) subsecund upon short approximate alternate appressed branchlets, pedicellate, lance-ovate, acute, pale green. Lower glume lance-ovate, acute, $\frac{1}{2}$–$\frac{2}{3}$ the length of the upper, membranaceous, 3-nerved, the base surrounding the spikelet; upper glume nearly the length of the neutral flower, 5-nerved, acute. Outer palea of the neutral flower 3-nerved, the inner subequal, hyaline; both acute. Stam. 3. Herm. fl. a little shorter than the neutral, coriaceo-membranaceous. Stamens much exserted and covering the whole panicle with pale yellow anthers; filaments very slender, arachnoid. Stigmas large, densely plumose, ochroleucous.—Fl. May—July. Society Hill, S. Car. Also, Santee Canal, S. C., *Mr. Ravenel*, and Louisiana, *Prof. Carpenter*. Margin of ponds in water 2–4 feet deep.

In the specimens from localities here given, I have never been able to find the grain, and the flowers are very deciduous. The ovary is lanceolate, acute.

ART. XXXVIII.—*On Gibbsite and Allophane, from Richmond, Mass.;* by Prof. B. SILLIMAN, JR., of Yale College.

GIBBSITE was first described by Dr. Torrey,* as a terhydrate of alumina ($\dddot{Al}\,\dot{H}^3$), and this constitution has been confirmed by the analyses of Dewey† and Thomson.‡ More lately, however, M. Hermann§ of St. Petersburg, has announced that the constitution of Gibbsite was that of a hydrous phosphate of Alumina $\dddot{Al}\,\dot{\dot{P}}+8\,\dot{H}$, and that the composition assigned to Gibbsite by Torrey, belongs only to the Hydrargillite of Rose. This result is quoted by Rammelsberg‖ in his third supplement, who regards it as quite conformable to his own admirable researches on the phosphates.¶ I was induced to repeat the analy-

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* New York Med. and Phys. Jour., No. 1, p. 68.

† Dewey. This Jour., i ser., ii, 2 and 9—where its close resemblance to Wavellite was noticed, and the minerals regarded as identical. It was at this time unknown to American mineralogists that Berzelius had but a short time before made known the real character of Wavellite as a phosphate and fluorid. Dr. Dewey in vol. iii, p. 239, (this Journal, 1821,) proposed the name Hydrargillite as the proper one for Gibbsite, then unknown by the latter name.

‡ Outlines of Mineralogy, i, 222. § Hermann, Jour. f. Pr. Chemie, xl, 32.

‖ Rammelsberg—Drittes supplement zu dem Handwörterbuch, 1847, p. 48.

¶ Rammelsberg untersuchung einiger natürlichen und künstlichen Verbindungen der Phosphorsäure; Pogg. An., B. lxiv, 407.

sis of Gibbsite, from a desire to satisfy my own doubts regarding it, and in the belief that it was quite probable that phosphate of alumina might have been regarded as alumina by those who had analyzed the mineral before M. Hermann, from the striking similarity of the two substances in nearly all their reactions. It will be seen in the sequel, however, that my results go to rëestablish the accuracy of Dr. Torrey's analysis and the ancient formula of this species.

I was bountifully supplied with excellent specimens of Gibbsite from the original locality in Richmond, Massachusetts, by the kindness of Dr. Stephen Reed, a gentleman well known to American mineralogists. Among the specimens sent to me were all the varieties of form which stalactitic and encrusting minerals ever assume, and many specimens were of remarkable size and perfection. Some specimens of the Gibbsite were covered with a pearly white lamellar mineral, encrusting and intimately associated with it, and which closely resembled allophane, which mineral, analysis proves it to be.

Physical Description.—Gibbsite occurs in stalactites often several inches long, in mamillary masses, and incrustations covering broad surfaces of iron ore and ferruginous rocks. The stalactites have a radiating subfibrous structure, and always enclose particles of iron ore as a nucleus. The crusts are generally the most free from foreign matter. No crystalline structure could be detected in any of the specimens. *Hardness* 3·5—3·75. *Density* 2·389. *Lustre* faint subvitreous. *Streak* white. *Color* white and grayish white, sometimes reddish and greenish. Yields a strong argillaceous odor when moistened or breathed on. Texture tough and adheres strongly to the polished surface of the agate pestle and mortar.

Pyrognostic characters.—In the close tube gives off water abundantly which is neutral, but has a decided empyreumatic odor. On charcoal it decrepitates strongly from the escape of water, and finally becomes opake; phosphoresces; moistened with nitrate of cobalt-solution, it gives when heated upon charcoal a bright blue slag like pure alumina. It dissolves to a transparent bead in salt of phosphorus acid, and in borax. Treated with the iron wire for phosphoric acid not the least evidence could be obtained, according to the method advised by Berzelius. By employing the method advised by Vauquelin and Thenard for detecting phosphoric acid in small quantity by means of potassium in a deep tube, a decided but not strong odor of phosphuretted hydrogen was obtained.

Chemical characters.—The finely pulverized mineral dissolves at once in strong potash or soda ley, leaving only a few flocs of peroxyd of iron. In boiling concentrated chlorohydric acid it is only in part soluble, unless after a very long time and with re-

peated doses of fresh acid. Concentrated sulphuric acid dissolves it with great energy. If the pulverized mineral is made into a paste with Nordhausen acid and the temperature be slightly raised, the action is so violent as to completely decompose the mineral in an instant, converting the whole into a solid mass with an evolution of great heat. This mass is perfectly soluble in water save a few milligrammes of silica and hydrous oxyd of iron mechanically present. It is evident therefore, that either sulphuric acid or the caustic alkalies must be used in attacking this mineral.

Water.—The water of the mineral was determined on three portions, selected from the purest specimens—the powdered mineral was dried at 212°, cooled over sulphuric acid, and ignited in a covered platinum crucible until a constant weight was obtained. The three trials gave successively

35·206—33·828—33·420. Mean 34·151 pr. ct. which is a little too low for the formula.

1st *Analysis.*—My first analysis of this mineral was made by the ordinary course of inorganic analysis without recourse to any special means for the separation of phosphoric acid.

1·565 grammes substance was dissolved in concentrated sulphuric acid, evaporated to dryness, and redissolved in water. The insoluble matter (silica and peroxyd of iron) weighed ·0278 gramme. The $\ddot{\mathrm{Al}}$ was separated from the filtrate by ammonia and weighed ·993 gramme. The filtrate from the alumina yielded on concentration and treatment with phosphate of soda, a small quantity of magnesia, weighing ·0047 gramme. No lime was present. The results of this analysis yield the following summary.

		Found.
Alumina,	·9930	= 63·446
Water,	·5395*	= 34·477
Magnesia,	·0047	= ·300
Insoluble residue,	·0278	= 1·777
	1·5650	= 100·000

			Calculated.
$\ddot{\mathrm{Al}}$	1 at.	= 642·33	= 65·56
$\dot{\mathrm{H}}$	3 "	= 337·44	= 34·44
		979·77	100·00

This analysis requires therefore, the formula $\ddot{\mathrm{Al}}\,\dot{\mathrm{H}}^3$. If the magnesia and insoluble matter are regarded as displacing so much alumina, the requirements of the formula will be exactly met, i. e., 63·446 + 2·076 = 65·522.

* By the difference.

I have not had the opportunity of seeing the original memoir of M. Hermann, in which he no doubt details his method of separating phosphoric acid from alumina. In the Annuaire de Chimie of MM. Millon and Reiset, for 1848, p. 155, an abstract is given of this paper of M. Hermann, which states that the results of Rose's analysis of hydrargillite, in which this chemist detected a small portion of phosphoric acid, led him to the re-analysis of Gibbsite, and that the results of this chemical examination gave the formula already quoted from Rammelsberg in the commencement of this article. His analysis of hydrargillite, states—

Water, ...	34·54
Phosphoric acid, ...	1·43
Alumina, ...	64·03
	100·00

For the separation of phosphoric acid from alumina in Gibbsite, M. Hermann states, as quoted in the Annuaire, that he "dissolved the Gibbsite in *hydrochloric* acid, and neutralized the solution by chalk—the precipitate obtained on the addition of ammonia was treated by hydrate of soda to dissolve out the alumina. The residue consisted of phosphate of lime."

2d *Analysis*.—As before stated, I find the Gibbsite not entirely soluble in hydrochloric acid. I therefore dissolved it in caustic soda, acidulated the solution with hydrochloric acid, neutralized with limewater, precipitated by ammonia, collected the precipitate by filtration, and re-dissolved the alumina by caustic soda. A small residue insoluble in this menstruum remained (=·036 grm.) which was presumed to be phosphate of lime colored by a little phosphate of iron. It is to be remarked, however, that the blowpipe gave very equivocal evidence of this precipitate containing any phosphoric acid. The alumina was then separated by carb. ammonia and weighed. The results of this analysis were on 1·0447 grammes substance taken:—

$\dddot{Al}$	·67859 grm.	=64 955
$\dddot{P}$	·00751 "	·590
H }	·35000* "	34·073
Mg }		·300
Insol.	·00860	·082
	1·04470	100·000

3d *Analysis*.—This last result was confirmed by the analysis of another portion of the mineral by the method proposed by Rammelsberg for the separation of phosphoric acid and alumina.

* By the difference.

This method is as follows: The mineral is dissolved in sulphuric acid, and a sufficient quantity of sulphate of potash is added. The whole solution (which should be not very bulky), is then mingled with a large quantity of strong alcohol ($\frac{8}{10}$) and allowed to stand for some hours. In this way alum and sulphate of potash separate, while $\dddot{S}$ and $\dddot{P}$ remain in solution. Then filter, wash the precipitate out with alcohol, dissolve the residue in water and precipitate the alumina by ammonia. The alcoholic filtrate, containing the $\dddot{S}$ and $\dddot{P}$ is next evaporated to expel the alcohol, supersaturated with ammonia and precipitated by chlorid of calcium. The precipitate always containing sulphate of lime, is washed only for a short time; it is then dissolved in hydrochloric acid and diluted with weak alcohol. Gypsum separates on standing and is removed by filtration, and from the filtrate, ammonia separates pure phosphate of lime.*

1·432 grammes of Gibbsite in fine powder were treated by this process, with every precaution to ensure accuracy. I obtained—

$\ddot{Al}$	= ·9209	64·160
$\dot{Ca}_2\dddot{P}$	= trace	trace
$\dot{H}$	·48778†	34·151
$\dot{Mg}$		·300
Insoluble	·0233	1·627
	1·432	100·238

That no doubt should remain, or any room for error, I further reanalyzed the alumina obtained from the analysis of the first portion of Gibbsite (I.) by the method of Berzelius, which I have often before used with success for the separation of phosphoric acid from alumina. It is briefly this: The substance is fused with 6 parts of pure carbonate of soda, and 1½ parts of pure silica. The phosphoric acid is thus transferred to the soda, and the alumina remains as an insoluble silicate, on treating the fused mass with successive portions of hot water. The filtrate is treated with bicarbonate of ammonia and boiled for some hours to separate a portion of basic silicate of alumina, which the alkaline menstruum had dissolved. The filtrate containing all the $\dddot{P}$ is acidulated with HCl boiled to expel carbonic acid, and being evaporated to a small bulk, ammonia and sulphate of magnesia are added to the cold solution, and the ammonio-magnesian phosphate allowed to crystallize out.

* Pogg. Ann., B. 54, 406.

† By the difference.

4th *Analysis.*—·908 gramme of alumina obtained in analysis No. 1, treated by the above process, gave

$$0{\cdot}0126\ \dot{\mathrm{M}}\mathrm{g}\ \ddot{\mathbf{P}} = {\cdot}677 \text{ per cent. of phosphoric acid.}$$

This quantity of phosphoric acid is equivalent to

·753 per cent. of phosphate of alumina.

The remainder was only alumina.

From the foregoing results, it is evident that the Gibbsite of Richmond, Massachusetts, corresponds to the formula first given, $\ddot{\mathbf{A}}\mathrm{l}\,\dot{\mathbf{H}}^3$, which requires

$\ddot{\mathbf{A}}\mathrm{l}$	65·156
$\dot{\mathbf{H}}$	34·440
	100·000

and the mean results of these analyses correspond very closely to the calculated per-centages. The phosphoric acid is therefore like the magnesia, iron and silica contained in Gibbsite, only a contingent impurity.

Allophane.

I have already remarked that some specimens of Gibbsite are coated by a hyaline crust, cleaving in laminated scales, sometimes opake white and pulverulent, and again perfectly limpid and colorless. It is extremely brittle, easily reduced to powder, and yields easily to the knife. Before the blowpipe it loses water and falls to a white powder, or loosely coherent slag. In salt of phosphorus leaves a siliceous skeleton. Gives off water abundantly in the close tube; this water is neutral. With nitrate of cobalt on charcoal it yields a blue slag, and it dissolves with effervescence in carbonate of soda.

A qualitative examination gave evidence of the presence of water, alumina, silica, and magnesia. The whole character of the mineral left no doubt that it was allophane, and the chemical analysis confirmed this conclusion. It was not easy to find a portion of the mineral which was perfectly homogeneous—or to separate entirely all those portions which had evidently undergone more or less decomposition.

After several analyses and repeated determinations of the quantity of water, I arrived at the following result, which if we regard magnesia as an accidental constituent, and distribute it and the loss between the silica and alumina, will give us almost precisely the per-centages required by the formula $\ddot{\mathrm{S}}\mathrm{i}^2\ \ddot{\mathbf{A}}\mathrm{l}^3 + 15\dot{\mathbf{H}}$, viz:—

	Atoms.		Calculated.	Found.	
2 $\dddot{Si}$	1154·62	=	24·211	22·654	
3 $\ddot{Al}$	0926·99		40·408	38·768	
15 $\dot{H}$	1687·20		35·421	35·240	
	4768·81		100·000	96·662	
				2·833	magnesia.
				0·505	loss.
				100·000	

If the magnesia is regarded as an essential constituent of the mineral, it gives a complicated and improbable formula, while it is not at all remarkable that a mineral formed by infiltrating waters as this evidently is, should contain a notable amount of foreign impurities.

I was struck with the resemblance which exists between these two associated species and the stalactitic concretions of hydrated aluminous silicates brought by Mr. Dana from the lava caves of volcanic Islands in the Pacific. These I have long since examined, and the results are contained in the Geological Report of the U. S. Exploring Expedition, by Mr. Dana.

There can no longer be any doubt of the identity of the Hydrargillite of Rose with Gibbsite;—the former is the crystalline, the latter the amorphous variety of the same species. It is not impossible that this same locality may furnish specimens of massive Wavellite, and perhaps it was such an one which gave to M. Hermann the result which has called out this article. The phosphoric acid of both Hydrargillite and Gibbsite is in too small quantity to be regarded as an essential constituent.

In conclusion I would say, that on a former occasion, in making a cursory qualitative examination of Gibbsite, I detected *silica* in it, and so reported it to Mr. Dana, and the statement is repeated in his smaller work. I have now no doubt that the portion of the mineral then examined, was contaminated with a portion of allophane—in fact, the examination was made upon the same specimens, in which, by closer observation, I have since detected the latter mineral. It requires some care to separate the two entirely, and I have little doubt that the silica, mentioned by Dr. Thomson in his analysis of Gibbsite, was derived from the same intermixture of the two species.

Analytical Laboratory, April 1, 1849.

ART. XXXIX.—*Notice of a Novel Mode of Discharging a Leyden Battery, with an explanation of its theory;* by J. H. LANE, of the Patent Office, Washington.

IN the London Mechanic's Magazine, vol. xlix, page 84, we notice a mode of discharging a Leyden battery, which is very beautiful in theory, and if not entirely new, is at least generally unknown, and some notice of it is therefore deemed proper in this Journal.

It has been publicly exhibited on a large scale, in a course of lectures delivered by Mr. Baggs, in the Polytechnic Institution, and an epitome of which was communicated to the Mechanic's Magazine, by John Mac Gregor, Esq.

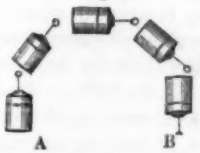
The arrangement of the jars in the new mode of discharging them, is precisely that which has often been employed in charging them, that is, in a series with the knob of each in connection with the outer coating of the next in the series. In the present case however, it is only in discharging that they are thus arranged. They are charged separately, or are first connected together in a battery in the ordinary way, with all the outer coatings connected together and with the earth and all the inner coatings connected and thus charged. Then when ready to discharge, they are by a simple movement all insulated and arranged in a series as above described, which series may be made to take a semicircular or U form, in order to bring the knob of the last jar in the series, into convenient proximity to the outer coating of the first jar. The effect of this arrangement of the charged jars is to multiply the *intensity* in a manner precisely analogous to that of the galvanic battery, so that if the outer coating of the first jar be supposed to be connected with the earth, and the number of jars twelve, the *knob* of the last jar of the series will be twelve times more highly electrified than the *knob* of either jar was before being thrown into series. Consequently, the disruptive force or space-penetrating power of the spark, will be correspondingly multiplied, and Mr. Baggs is said to have discharged his battery of twelve large jars through a space of about three feet. It is hardly necessary to remark, that in this way of discharging the battery, the *quantity* of the spark is only that of a single jar. Hence to pursue experiments on this plan with any satisfaction, large jars must be used, with an abundant source of electricity from a powerful machine. Mr. Baggs employed a steam electric machine.

The method employed by him, of making the necessary changes of arrangement in the jars, is quite simple. Each jar is supported in a horizontal position on a vertical spindle, and the

several jars are arranged as shown in fig. 1, to be charged; but part of a revolution given to each spindle will bring them into series as show in fig. 2, when the discharge will take place between A and B.

Fig. 1.

Fig. 2.



That the multiplication of the intensity will actually take place as above stated, may easily be proved from the known phenomena of a single jar. The general principle concerned, is that if a ball N be connected with the outer coating of a charged jar and a ball P with the inner coating, the difference between the quantities* of free electricity in the balls N and P, is constant, or approximately so, though the quantities themselves be varied.

Thus, let us suppose the jar to be charged to such a degree that with N in its natural state, P is found by the electrometer to have a quantity of free electricity denoted by a. Then, the jar being insulated, it is known that if a quantity q of free electricity be given to N, a corresponding additional quantity is set free from the inner coating of the jar in consequence of the diminished induction of the outer coating, and thus P will exhibit approximately, and probably exactly, the quantity $q+a$ of free electricity. Hence, if many other jars be also charged to the same degree, and connected in a series with the outer coating of the first in connection with the earth, the P of the first jar must have the quantity a of free electricity, the second jar having its $N=a$ must have its $P=2a$, and the third jar having its $N=2a$ must have its $P=3a$, &c.

"We have thus," says Mr. Mac Gregor, "a new feature introduced into our manipulation of Franklin electricity—the simultaneous change in position of each jar of the battery; and whilst its first results enable the electrician to exhibit a disruptive spark of great power, we can set no limits to the expectations we may indulge in from its full development."

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* The word quantity in this connection is not used in its more common sense, but is adopted as being best suited to my present purpose. I mean by it the quantity of *free* electricity in a *unit* of surface of the ball N or P. In this sense the *quantity* of *free* electricity is a measure of the *intensity* or rather *tension*.

ART. XL.—*On the Action of Nitric Acid on Sebacic Acid;* by ADOLPH SCHLIEPER.

IT is quoted in all chemical hand-books, that sebacic acid is not altered by treatment with nitric acid; but the similarity of many of its physical properties with benzoic acid authorized the conjecture that, like the latter it might be converted into *nitro-sebacic acid* $C_{10}H_7O_3NO_4$. In all cases it was interesting to know, if the action of nitric acid on this constant product of decomposition of oleic acid at high temperatures, did not cause the formation of one or more of those acids which Laurent produced by direct action on oleic acid by this agent.

The sebacic acid employed in this research was obtained by dry distillation of the crude commercial oleic acid. The distillate was boiled with water several times, the watery extracts saturated with carbonate of soda, and evaporated to dryness; to remove the caprylate and caprinate of soda; the dry saline mass was then exhausted with hot absolute alcohol, which left the sebacate of soda undissolved. The latter was then dissolved in water and the sebacic acid precipitated by addition of muriatic acid; after being purified by several repeated crystallizations from water, it presented itself as a loose, very light, white mass, consisting of small shining scales.

To examine the formation of nitro-sebacic acid, one part of sebacic acid was heated with 20–30 parts crude nitric acid, spec. gr. 1·4, in a spacious matrass; no solution is effected when cold, but it takes place perfectly a little below the boiling point; at the same time the orange colored vapors of hyponitrous acid and the like color which the liquid assumes, indicate a decomposition of the sebacic acid. The nitric solution was then kept at a continual slow boiling on a sandbath, in such a manner that the evaporating nitric acid condensed for the greater part in the long neck of the matrass and flowed back. After 2–3 hours boiling, a small part of the solution was poured out, to see if the formation of a nitro-sebacic acid had taken place, though the continual but very slow development of red vapors, indicated clearly, that the decomposition was not yet finished.

The hot nitric solution, mixed with 8–10 times its volume of cold water, separated a great quantity of probably unaltered sebacic acid, which having been washed out and dried, showed all the physical properties of that substance. I prepared and analyzed the silver salt of acid so obtained, and thus proved that it was only unaltered sebacic acid. 0·312 grm. of the silver salt gave 0·161 grm. silver, which corresponds to an amount of oxyd of silver of 55·41 per cent. Sebacate of silver contains 55·76 per cent. oxyd of silver.

I may here mention an easy method of obtaining perfectly snow-white sebacic acid, this material having generally a yellowish tint. It is sufficient, just to boil one part of impure sebacic acid with 5–6 parts of nitric acid, spec. gr. 1·35, and then mix the solution with a great quantity of boiling water; by cooling, the sebacic acid crystallizes perfectly pure.

The rest of the solution of sebacic acid in nitric acid, was kept continually boiling, till the entire cessation of the formation of nitric oxyd, constantly renewing the evaporating nitric acid. The oxydation takes place very slowly; it required eight days for a quantity of about 200 grains of sebacic acid. After the solution had changed its orange to a nearly white color, and the development of nitric oxyd ceased, the contents of the matrass were poured into a flat basin, diluted with an equal volume of water, and on the waterbath the nitric acid slowly driven off, using the precaution of adding from time to time a small quantity of water. The white residue was then dissolved in water, filtered and evaporated to a syrup, on the waterbath; then allowed to crystallize over sulphuric acid. Regular crystals could not be obtained perhaps, because the quantity of the solution was not sufficient; but the whole solution solidified very soon and became a white crystalline mass somewhat sticky, appearing like pure grape sugar crystallized in a similar way. This substance, in a perfectly pure state, is a strong acid, and the only product which results from the action of nitric acid on sebacic acid. It is, as will presently be proved, identical in composition and quality with *pyrotartaric acid*, as far as a comparison was possible with the fluctuating reports we possess about the latter.

For analysis, the acid was dried over sulphuric acid, and afterwards melted, but without sustaining any loss in its previous weight; it was burnt with chromate of lead and gave the following results:

(1.) 0·349 grm. substance gave 0·579 grm. carbonic acid, and 0·1915 grm. water.

(2.) 0·3293 grm. substance gave 0·5485 grm. carbonic acid, and 0·1805 grm. water.

From this is derived the formula:

$C_5 H_4 O_4 = C_5 H_3 O_3 HO$ = hydrate of pyrotartaric acid.

		Calculated.	Found.	
			I.	II.
C_5	30	45·45	45·27	45·42
H_4	4	6·06	6·09	6·09
O_4	32	48·49	48·64	48·49
$C_5 H_4 O_4 =$	66	100·00	100·00	100·00

Hence one equivalent of sebacic acid takes up five equivalents of oxygen by oxydation with nitric acid, and changes itself in two equivalents of the hydrate of pyrotartaric acid.

1 equivalent of sebacic acid, $= C_{10}H_8O_3$
5 " " oxygen, $= O_5$

2 equivalents of the hydrate of pyrotartaric acid $= C_{10}H_8O_8 = 2(C_5H_3O_2, HO)$

This acid thus differs from lipinic acid, which it resembles in many properties, only by one equivalent less of oxygen. The acid in question has the following qualities, which coincide very nearly with those of pyrotartaric acid, as stated by Pelouze; the very slight deviations in regard to the crystallization of the acids, it was impossible for me to reconcile, on account of the small quantity of the new acid which I could command. The acid presents itself as a perfectly white, slightly crystalline mass, a little sticky, and permanent in the air; heated in a waterbath, it became half fluid, but heated a few degrees above 100° Centigrade, it melted into a watery clear fluid, solidifying when cooled into a crystalline mass. Very cautiously heated on platinum, it volatilizes entirely, evolving a white suffocating vapor. Heated between two watch crystals it sublimes, leaving a carbonaceous residue, in strong shining prismatic needles, which show all the reactions of the unsublimed acid. The acid is inodorous, and has a very acid taste, similar to that peculiar to succinic acid. It is easily soluble in water, alcohol and ether, also in concentrated sulphuric acid without being decomposed. Heated with alcohol and sulphuric acid the ether of this acid is readily formed, which is distinguished by a peculiar aromatic odor. The watery solution drives out carbonic acid with effervescence, and forms gum-like salts with potash, soda and ammonia, when evaporated briskly, but whose concentrated solutions allowed to evaporate above sulphuric acid, dry to crystalline masses. The ammonia salt loses ammonia in evaporating and becomes acid. The alkaline salts are soluble in alcohol, furnish no precipitates with baryta and lime salts, with chlorid of iron a flocculent brownish red precipitate, soluble in a pretty large quantity of boiling water; with copper salts results a light green precipitation. With acetate of lead, no precipitate results, but after two to three hours the mixtures of the solutions not too much diluted, deposit a white lead-salt in granules, principally adhering to the sides of the vessels; once separated they are difficultly soluble in water. If an addition of alcohol is made to the mixed solutions of acetate of lead and the ammonia salt of the acid, a thick white precipitate is produced directly, melting to small drops when heated, and evidently the same precipitate which deposits after a longer standing of the solutions, without additions of alcohol. The ammonia salt gives

with basic acetate of lead a thick curdy precipitate, cohering after some hours, easily soluble as well in acids as in an excess of basic acetate of lead. Nitrate of silver is precipitated by the ammonia salt in white flocs very like fresh precipitated alumina.

All these qualities mentioned, agree so perfectly with those of pyrotartaric acid as described by Pelouze, that, considering the similarity of the composition of both acids, I do not hesitate in the least to proclaim the identity of pyrotartaric acid with the acid obtained by oxydation of sebacic acid with nitric acid.

From the statements of Weniselos my own differ, only in regard to the ammonia salt, which the first pretends to have obtained in fine crystals; and in regard to the neutral lead salt, which ought to deposit itself after a certain time in fine needles, whereas Pelouze, as well as myself, obtained only granulated precipitates, under the same conditions.

For further analysis I selected the silver salt, which was prepared by precipitating the nitrate of silver with the ammonia salt of the acid; but I am sorry to say, that I did not succeed in obtaining it of a constant composition, which is very remarkable in a silver salt. I procured from salts of two different preparations 2–3 per cents. of oxyd of silver less than the formula AgO, PT required, though the acid combined with it, calculated by itself, after deduction of the mean amount of oxyd of silver, corresponded exactly to the formula of the anhydrous acid.

The silver salt is very sensible to light, dries slowly and forms semi-transparent hard pieces, very like the dried hydrate of alumina; which become brownish white when powdered. The analysis gave the following results:

I. *Preparation.*—(1.) 0·3358 grm. silver salt gave 0·2005 grm. silver = 0·2153 grm. oxyd of silver.

(2.) 0·4038 grm. silver = 0·2415 grm. silver = 0·2585 grm. oxyd of silver.

(3.) 0·6715 grm. silver gave by combustion with chromate of lead, 0·465 grm. carbonic acid, and 0·1245 grm. water.

II. *Preparation.*—(1.) 0·3355 grm. silver salt gave 0·2027 Ag = 0·21777 oxyd of silver.

(2.) 1·0034 grm. silver salt, burnt with chromate of lead, gave 0·675 grm. carbonic acid and 0·178 grm. water.

This calculated in per cent. gives,

	I. Preparation.			II. Preparation.	
	I.	II.		I.	II.
AgO	64·11	64·01	. .	64·88	. .
C	. .	. .	18·88	. .	18·34
H	. .	. .	2·06	. .	1·97

Pyrotartrate of silver would correspond with:

	Calculated.	
1AgO	116	67·05
5C	30	17·35
3H	3	1·73
3O	24	13·87

If now the mean amount of oxyd of silver is deducted from the analysis as above, and the equivalents of carbon, hydrogen and oxygen combined with it, calculated on the hundred parts, then we obtain exactly the percentage numbers of the anhydrous pyrotartaric acid as will be seen from the following comparison.

	Calculated.		Found.	
			I.	II.
C_5	30	52·63	52·53	52·22
H_3	3	5·26	5·73	5·60
O_3	24	42·11	41·74	42·18
$C_5H_3O_3=57$		100·00	100·00	100·00

The lead precipitate which results from basic acetate of lead in the ammonia salt of the acid, has been dried and analyzed.

(1.) 0·321 grm. substance gave 0·3195 grm. sulphate of lead $=0·23503$ oxyd of lead.

(2.) 0·4655 grm. substance gave 0·460 sulphate of lead.

(3.) 0·3585 grm. substance (of a different preparation) gave 0·3585 grm. sulphate of lead.

This amount of oxyd of lead corresponds exactly with the formula:

$C_{10}H_7O_7 + 3PbO = 2(PbO, C_5H_3O_3) + PbO, HO$, as results from the comparison of the found and calculated values.

	Calculated.		Found.		
			I.	II.	III.
3PbO	335·1	73·12	73·21	72·70	73·0
$C_{10}H_7O_7$	123·0	28·88	. .	. .	. .

A further comparison of this acid with pyrotartaric acid, will be possible only, when the latter has been submitted to a more fundamental investigation; but from the statements above, the identity of these acids can hardly be doubted.

Lowell, April 4th, 1849.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Crystalline Polarity of Bismuth and other bodies, and on its Relation to the Magnetic Form of Force;* by Dr. Faraday, (Proc. Roy. Soc., Athen., No. 1103, Dec. 16.)—The author states that in preparing small cylinders of bismuth by casting them in glass tubes, he had often been embarrassed by the anomalous magnetic results which they gave, and that having determined to investigate the matter closely, it ended in a reference of the effects to the crystalline condition of the bismuth, which may be thus briefly stated. If bismuth be crystallized in the ordinary way, and then a crystal, or a group of symmetric crystals, be selected and suspended in the magnetic field between horizontal poles, it immediately either points in a given direction or vibrates about that position, as a small magnetic needle would do, and if disturbed from this position it returns to it. On resuspending the crystal so that the horizontal line which is transverse to the magnetic axis shall become the vertical line, the crystal then points with its maximum degree of force. If it be again resuspended so that the line parallel to the magnetic axis be rendered vertical, the crystal loses all directive force. This line of direction therefore, which tends to place itself parallel to the magnetic axis, the author calls the *magne-crystallic axis* of the crystal. It is perpendicular, or nearly so, to the brightest and most perfect of the four cleavage planes of the crystal. It is the same for all crystals of bismuth. Whether this magne-crystallic axis is parallel or transverse to the magnetic axis, the bismuth is in both cases repelled from a single or the stronger pole; its diamagnetic relations being in no way affected. If the crystal be broken up, or if it be fused and resolidified, and the metal then subjected to the action of the magnet, the diamagnetic phenomena remain, but the magne-crystallic results disappear, because of the confused and opposing crystalline condition of the various parts. If an ingot of bismuth be broken up and fragmentary plates selected which are crystallized uniformly throughout, these also point; the magne-crystallic axis being, as before, perpendicular to the chief plane of cleavage, and the external form, in this respect, of no consequence. The effect takes place when the crystal is surrounded by masses of bismuth, or when it is immersed in water or solution of sulphate of iron, and with as much force apparently as if nothing intervened. The position of the crystal in the magnetic field is affected by the approximation of extra magnets or of soft iron; but the author does not believe that this results from any attractive or repulsive force exerted on the bismuth, but only from the disturbance of the lines of force or resultants of magnetic action, by which they acquire as it were new forms; and, as the law of action which he gives is, that *the line or axis of magne-crystallic force tends to place itself parallel, or as a tangent, to the magnetic curve or line of magnetic force, passing through the place where the crystal is situated*, so the crystal changes its position with any change of direc-

tion in these lines. After noticing the magne-crystallic condition of various bodies, the author enters upon a consideration *of the nature of the magne-crystallic force.* In the first place he examines closely whether a crystal of bismuth has exactly the same amount of repulsion, diamagnetic or otherwise, when presenting its magne-crystallic axis *parallel* or *transverse* to the lines of magnetic force acting on it. For this purpose the crystal was suspended either from a torsion balance, or as a pendulum thirty feet in length, but whatever the position of the magne-crystallic axis, the amount of repulsion was the same. In other experiments, a vertical axis was constructed of cocoon silk, and the body to be examined was attached at right angles to it as radius; a prismatic crystal of sulphate of iron, for instance, whose length was four times its breadth, was fixed on the axis with its length as radius and its magne-crystallic axis horizontal, and therefore as tangent; then, when this crystal was at rest under the torsion force of the axis, an electro-magnetic pole with a conical termination was so placed that the axial line of magnetic force should be, when exerted, oblique to both the length and the magne-crystallic axis of the crystal; and the consequence was, that, when the electric current circulated round the magnet, the crystal actually *receded* from the magnet under the influence of the force, which tended to place the magne-crystallic axis and the magnetic axis parallel. Employing a crystal or plate of bismuth, that body could be made to *approach* the magnetic pole under the influence of the magne-crystallic force; and this force is so strong as to counteract either the tendency of the magnetic body to approach or of the diamagnetic body to retreat, when it is exerted in the contrary direction. Hence the author concludes that it is neither attraction nor repulsion which causes the set or determines the final position of a magne-crystallic body. He next considers it as a force dependent upon the crystalline condition of the body, and therefore associated with the original molecular forces of the matter. He shows experimentally, that, as the magnet can move a crystal, so also a crystal can move a magnet. Also that heat takes away this power just before the crystal fuses, and that cooling restores it in its original direction. He next considers whether the effects are due to a force altogether original and inherent in the crystal, or whether that which appears in it is not partly induced by the magnetic and electric forces; and he concludes, that the force manifested in the magnetic field, which appears by external actions and causes the motion of the mass, is chiefly, and almost entirely *induced*, in a manner subject indeed to the crystalline force and additive to it; but at the same time exalting the force and the effects to a degree which they could not have approached without the induction. To this part of the force he applies the word *magneto-crystallic*, in contradistinction to magne-crystallic, which is employed to express the condition or quality or power which belongs essentially to the crystal. The author then remarks upon the extraordinary character of the power, which he cannot refer to polarity, and gives expression to certain considerations and views which will be best learned from the paper itself. After this, he resumes the consideration of Plucker's results "*upon the repulsion of the optic axes of crystals*," already referred to, and arrives at the conclusion that his results and

those now described have one common origin and cause. He then considers Plucker's results in relation to those which he formerly obtained with heavy optical glass and many other bodies. In conclusion he remarks, "how rapidly the knowledge of molecular forces grows upon us, and how strikingly every investigation tends to develop more and more their importance and their extreme attraction as an object of study. A few years ago magnetism was to us an occult power affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relations with electricity, heat, chemical action, light, crystallization, and, through it, with the forces concerned in cohesion; and we may, in the present state of things, well feel urged to continue in our labors, encouraged by the hope of bringing it into a bond of union with gravity itself."

2. *Method of obtaining crystalline combinations by Heat, and of reproducing thereby various mineral species;* by M. EBELMAN, (Comptes Rendus de l'Acad. des Sci., t. xxv, pp. 279 and 661; Annuaire de Chemie, 1848, p. 141.)—It is known that borax, boracic acid, phosphoric acid, and the alkaline phosphates, dissolve metallic oxyds with ease, at a certain temperature, and abandon them at a much higher temperature by virtue of their volatility. These bodies enjoy, therefore, in regard to the oxyds which they hold in solution, the function which water possesses at the ordinary temperature, or at temperatures more elevated in relation to bodies held in solution by it,—that very often on evaporating it leaves such bodies in a crystalline condition. This simple principle has led M. Ebelman to a method which will enrich chemistry by the dry method, with a great number of novel combinations, and which will establish the most intimate connection between mineralogy and chemistry. On mingling together, for example, alumina and magnesia in a little larger proportion than they exist in spinel, with a portion of fused boracic acid, and exposing the mixture to the most elevated temperature of a porcelain furnace, octahedrons are obtained which possess the composition and properties of spinel. These crystals are rose-red or blue according as the oxyd of chrome or of cobalt is used. M. Ebelman has obtained in this way chrysoberyl $Al^2 O^3$, $Gl O$, and many other aluminates. He has obtained the compound $Cr^2 O^3 + MgO$, crystallized in regular octahedrons. He has prepared many varieties of chrome iron which all present regular octahedrons with the usual mineralogical characters; in their composition they approach spinel and the compound $\dot{\dot{C}}r\ Mg$.

By the aid of this process, M. Ebelman has also obtained the emerald and peridot crystallized.

Boracic acid is too volatile to aid in crystallizing alumina, and in this case he employed borax. By the addition of a little oxyd of chrome, crystals of red ruby are obtained, having the formula of transparent corundum.

3. *Researches upon Wax;* by BENJAMIN COLLINS BRODIE, (Philos. Mag. for Sept. and Nov., 1848, from the Phil. Trans.)—This research has settled a hitherto disputed subject in a most satisfactory manner, and the care exhibited in the processes employed and the analytical results entitle it to great confidence.

Bees-wax is, by the action of boiling alcohol, separated into a soluble portion which has been called *cerine* and a *comparatively* insoluble substance designated *myricine*. The cerine by repeated solution in boiling alcohol may be obtained in an approximately pure state; it then fuses at about 70° or 72° C. and is readily soluble in caustic potash. If a boiling alcoholic solution of this is mixed with an alcoholic solution of acetate of lead also boiling, a voluminous precipitate is obtained which is boiled with repeated portions of alcohol as long as this takes up anything. The lead salt is then decomposed by acetic acid and yields a highly crystalline acid which separates from its alcoholic solution on cooling, in fine grains; it melts at 78° C. To this substance the name of *cerotic acid* is given; the analysis of the acid and its salts shows that it is monobasic and has the formula $C_{54}H_{54}O_4 = C_{27}H_{54}O_2$ according to M. Gerhardt's notation. The ether is obtained by the usual process, and its analysis confirms the composition above ascribed to the acid. By the action of chlorine a substitutive product is obtained, which formula is $C_{27}(H_{42}Cl_{12})O_2$; it is still an acid and yields an ether corresponding to the one just noticed. Cerotic acid when pure is volatile for the greater part, without change, but when mixed with the other materials of the wax it is completely decomposed by distillation. To prove that the cerotic acid is really an ingredient of the wax and is not found in the process, Mr. Brodie has shown that by repeated crystallization of the cerine from ether, it at last acquires the fusing point and composition of the cerotic acid obtained by the other process. The proportion of cerotic acid as ascertained by precipitation with acetate of lead, was found in one specimen to be 22 per cent.; and it was generally present in the English wax as submitted to examination. The investigations upon the tree-wax of China, however, showed the complete absence of cerotic acid and gave rise to the discovery of the alcohol of that acid.

This wax which is an article of commerce from China, appears from the best accounts to be the product of an insect, the *Coccus ceriferus*, which feeds upon the *Rhus succedaneum* and some other trees. It is white and crystalline, resembling spermaceti, but is harder, more brittle, and more fibrous in its structure; it fuses at 83° C., and is little soluble in alcohol or ether, but dissolves readily in naphtha and may be crystallized from it. It is insoluble in solution of potash but by fusion with caustic potash is decomposed. By decomposing the solution of this in water by chlorid of barium and washing the baryta salt with alcohol, a neutral crystalline substance is obtained which when purified by crystallization in ether melts at 79° C. Its analysis leads to the formula $C_{54}H_{56}O_2$ or $C_{27}H_{56}O$. It is evidently, therefore, homologous with spirit of wine and ethol and is the alcohol of cerotic acid, the homologue of acetic and etholic acids. To this new alcohol, the author applies the name of *cerotine*; but *cerotol* should be substituted in accordance with the nomenclature of the French chemists, to which we have generally conformed, and which restricts the termination *ine* or *in* to alkaloids. When heated with potash-lime, cerotol evolves hydrogen gas and yields cerotate of potash, the identity of which with that obtained from bees-wax was determined by analysis.

Cerotol is soluble in concentrated sulphuric acid and water, precipitates from the solution a new substance soluble in alcohol and to some extent in water; it may be crystallized from ether; its analysis leads to the formula $SO_3\,C_{54}\,H_{55}\,O+HO$, and our author designates it as the *sulphate of the oxyd of cerotyle.* It appears to be *sulphocerotol* the homologue of sulphomethol, but the equivalent of water which Mr. Brodie obtains in his analysis, makes it an altogether anomalous compound. If we conceive this to be water of crystallization, or to be accounted for by a slight error in the analysis of a body of so high an equivalent, its formula becomes $S\,(C_{27}\,H_{55})_2\,O_4$ or $C_{54}\,H_{110}\,SO_4$ in M. Gerhardt's notation ($=C_{54}\,H_{55}\,O+SO_3$), and it is homologous with sulphomethol.

Cerotol, by the action of chlorine, gives rise to a body which appears to correspond to a chlorinized cerotic aldehyde. By a high temperature cerotol is volatile; it distils in part unchanged and is in part converted into a hydrocarbon and water.

The part of the wax which is rendered soluble by fusion with potash is found to be pure cerotic acid identical with that obtained from beeswax. By distillation the Chinese wax also yields a portion of cerotic acid in the earlier part of the process, which is separated from the hydrocarbon formed by solution in potash. This consists principally of a solid crystalline substance which resembles paraffine and fuses at about 58° C. Its formula is $C_{27}\,H_{54}$, so that it appears to be a homologue of olefiant gas and cetene; it is called *cerotene.* By the prolonged action of chlorid upon cerotene it yielded successive products, in which analysis showed a progressive substitution of chlorine for the hydrogen; the last gave the formula $C_{27}\,(H_{32}\,Cl_{22})$. An attempt to determine the density of the vapor of cerotene was unsuccessful, and on investigation, Mr. Brodie found, that by repeated distillations, even in a sealed tube, it was converted into a mixture of liquid hydrocarbons of boiling points varying from 75° C. to above 260° C.

The Chinese wax itself appears to be a compound ether homologous with spermaceti; its analysis leads to the formula $C_{54}\,H_{108}\,O_2$; this by the assimilation of $H_2\,O$ is converted into cerotol and cerotic acid $C_{54}\,H_{108}\,O_2+H_2\,O_2\,C_{27}\,H_{56}\,O+C_{27}\,H_{54}\,O_2$. In a third memoir Mr. Brodie proposes to give the results of his investigation of myricine.

T. S. Hunt.

4. *On Chloropicrine;* by John Stenhouse, PH. D., (Philos. Mag., July, 1848.)—When an aqueous solution of nitropicric acid is poured over an excess of hypochlorite of lime, the mixture heats spontaneously and evolves pungent vapors, and by artificial heat a large amount of a colorless oil distils over with the vapors of water to which the author has given the name of *chloropicrine.* When a clear solution of the hypochlorite is used, a quantity of carbonate of lime separates; a similar decomposition of nitropicric acid is effected by chlorine gas, by mixture of chlorate of potash and hydrochloric acid and by aqua regia, but with the simultaneous production of chloranile. When freed from acid by digestion with carbonate of magnesia, and from water by chlorid of calcium, it is a colorless neutral liquid which boils at 120° C., and has a sp. gr. of 1·6657; its odor is aromatic and when undiluted very pungent, resembling oil of mustard. It is soluble in alcohol and ether,

but nearly insoluble in water, and may be boiled with nitric, muriatic or sulphuric acids without change. By heat it decomposes potassium with violence, but in the cold a mixture of chlorid of potassium and nitre is gradually formed. Watery solutions of alkalies do not affect it, but an alcoholic solution slowly decomposes it, with the separation of nitre and chlorid of potassium. Dry ammonia produces a similar decomposition. By passing its vapor through a tube below a red heat, it is decomposed into chlorine, nitrous oxyd, and a chlorid of carbon, *acetene perchlore* of Gerhardt ($C_2 Cl_6$).

Its analysis gave C 6·30—6·66—6·72. Cl 64·47—64·83. H 0·26—0·22, and a comparison of the volumes of nitrogen and carbonic acid gas from its combustion, gave 1 : 2, making the nitrogen =7·78 per cent., and the oxygen 21·09—21·70; from these Dr. Stenhouse deduces the formula $C_4 Cl_7 N_2 O_{10}$, which accords sufficiently well with analysis but is quite improbable, inasmuch as the sum of the chlorine and nitrogen is not an even number. He rejects the 0·26 of hydrogen as accidental, *but this quantity corresponds exactly to one equivalent* and the formula then becomes $C_4 (HCl_7) N_2 O_{10}$, which is no longer anomalous.

This singular substance requires further examination and deserves to be studied in its metamorphoses by alkalies and reducing agents. It is probable from the large amount of oxygen, as well as from its origin, that the nitrogen is to be viewed as associated with oxygen replacing hydrogen, and the normal compound would then be $C_4 H_{20} O_2$, the formula of chloropicrine being written $C_4 (H_2 Cl_{14} X_4) O_2$.

T. S. H.

5. *On Turpentine Camphor;* by Dr. C. List, (Chem. Gazette, Aug. 1st, 1848, from Jour. für Prakt. Chem., vol. xliii, p. 499.)—This substance is obtained when moist oil of turpentine is exposed to cold, but more abundantly by the process of Wigger, which consists in mixing the oil with alcohol and nitric acid and allowing it to stand for some months. The author adopts for this substance the name of *terpine*, proposed by Berzelius, but for the sake of uniformity, that of *terebol*, proposed by Gerhardt, is preferable. It crystallizes in the trimetric system; the crystals melt with a gentle heat, losing 2 equiv. of water, and are converted into a white opaque mass, which readily absorbs water from the atmosphere, and has the composition $C_{20} H_{20} O_4$. It melts at 217° F., and at a higher temperature sublimes in a current of air condensing in long prisms. Its hot aqueous solution undergoes a singular change by the action of the acids; the liquid becomes milky and acquires a fragrant odor, and by distillation a volatile oil is obtained to which the discoverer has applied the name of *terpinole*. The weakest acids effect this change; one drop of sulphuric acid is sufficient to decompose an ounce of terebol. Terpenole is a colorless oil, having a fragrant odor like hyacinths; it has a sp. gr. of ·852, and boils at 334°. Its formula is $C_{20} H_{17} O$, and it is hence formed from terebol by the loss of the elements of 3 eq. of water.

Terebol absorbs hydrochloric acid gas with the evolution of heat, and water is also probably disengaged. The mass which results on cooling when recrystallized from alcohol, yields large plates which melt at 122° C., have the formula $C_{20} H_{18} Cl_2$, when heated with

water or alcohol they are resolved into terpinol and hydrochloric acid by assimilating one eq. of water. The same compound is directly formed by the action of hydrochloric acid gas on terpinol; it is isomeric with the hydrochloric compound of oil of lemons, but differs from it in its properties. The action of anhydrous phosphoric acid upon terebol removes all the oxygen as water, and yields an oil which is identical in composition with oil of turpentine.

[Dr. List appears to have overlooked the important relations of this substance as one of a series of homologous oils, four of which have been studied. The formula which he proposes should be doubled to accord with the equivalents adopted by the German chemists, and then writing its formula $C_{40}H_{68}O_2$, we have a number of equivalents of hydrogen divisible by 4. But in M. Gerhardt's notation its formula will be $C_{20}H_{34}O$, referring it to the form $R^{-6}O$. We have of this series by the discovery of terpinol at least five known compounds; phenol C_6H_6O, anisol C_7H_8O, carvacrol $C_{10}H_{14}O$, cedrol $C_{16}H_{26}O$, and terpinol $C_{20}H_{34}O$, which appear to be homologous. The carbohydrogen which the latter yields by anhydrous phosphoric acid, will be probably $C_{20}H_{32}$, homologous with cerdrene which is formed by the same process from cedrol, and with cinnamene. These homologies point out an interesting field for research in examining the reactions of the last three oils with chlorine, nitric acid and ammonia.]

T. S H.

6. *Improved Method of preserving Milk, patented by* F. H. F. Louis, (Chem. Gaz., Jan., 1849.)—The milk is to be mixed with well clarified raw sugar, 4 oz. to the gallon. It is then to be evaporated with agitation; when nearly solid it must be pressed into cakes of suitable size.

Steam may be used for the evaporation, or if time is no object, spontaneous evaporation in very shallow pans, with the fluid not more than one-tenth of an inch in depth, or a drying chamber may be used, the temperature not to exceed 122° F.

The cakes remain sweet and fresh for a long time and are soluble in warm water. Another process is, to heat the sweetened milk nearly to the boiling point, and before it becomes cold to curdle it by rennet or a weak acid. The curd is separated from the whey, and by strong pressure after washing in cold water, it is obtained free from adhering water. The whey is to be evaporated to dryness. The curd placed over a slow fire is continually stirred, and the dried whey added very gradually, with a small portion of bicarbonate of soda. After a while the ingredients melt and unite. A small quantity of finely pulverized gum-dragon, hastens the solidification.

Cream may be preserved by the same methods.

G. C. Schæffer.

7. *On a New Method for Amalgamating Zinc;* by Prof. O. N. Stoddard, Miami University, Ohio, (in a letter to one of the Editors.)—This method consists in the employment of double chlorid of zinc and ammonia, (the same solution which is so useful in soldering iron and steel.

The zinc to be amalgamated, is heated to about 450° F. or 500° F., and the liquid applied by a cloth or sponge and the mercury suffered to flow immediately over the surface while still moist.

The union is instantaneous and complete, and the depth of the amalgamation is easily regulated by the quantity of mercury suffered to remain in contact with the zinc.

This method is applicable even when the zinc is thoroughly oxydized on the surface; but if it has been previously used in a galvanic battery, it is best to cleanse the surface first by immersion in somewhat concentrated hydrochloric acid.

A set of Grove's cylinders thus amalgamated, it is stated, have been used at Miami University during a long course of lectures without serious injury and without re-amalgamation.

8. *A Magneto-Tangential Machine*, (in a letter from Prof. O. N. STODDARD.)—The instrument, a description of which is given below, was invented during the winter of 1848, while engaged in a course of lectures upon galvanism, and was intended to exhibit the tangential force of a magnet. As originally constructed, the brass ring within which the spindle revolves, was attached to the top of a wooden cup.

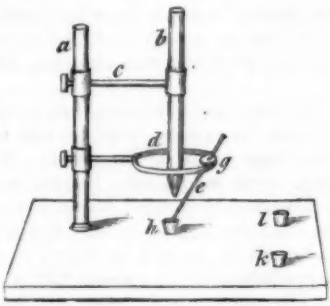
For the present modified form which dispenses with the cup, the writer is indebted to the suggestions of Dr. Locke of Cincinnati.

a. An upright pillar or rod of metal.

b. A permanent magnet from 4 to 6 inches in length, and $\frac{3}{4}$ inch in diameter.

c. Arm to support the magnet.

d. A ring of brass attached to the upright, $2\frac{3}{4}$ inches in diameter, and $\frac{1}{2}$ in width, the inner surface beveled, making the lower diameter $\frac{1}{4}$ inch less than the upper.



e. A spindle of copper or brass, 3 inches long and about $\frac{1}{10}$ inch thick, with a circular disk (*g*) of the same metal $\frac{3}{4}$ inch in diameter. The spindle should be carefully turned, and the lower end reduced to a fine point.

h. A cup of brass in which the spindle rests.

l, *k*. Mercury cups, one connected through the upright (*a*) with the ring (*d*), the other with the cup (*h*). As the spindle rests on a fine point, while its disk rolls on the inside of the ring, it revolves with the application of a very slight force.

If one or two drops of mercury be placed in the cup (*h*), a free passage is afforded for the battery current from one mercury cup, through the spindle ring and upright, to the other.

The current is not broken by the revolution of the spindle as its disk is constantly in contact with the ring. On connecting the instrument with a battery, the spindle revolves rapidly around the magnet. With a small battery of copper and zinc, it has made two hundred and fifty revolutions in a minute, and with a few cups of a Grove's battery, more than three hundred.

II. Mineralogy and Geology.

1. *Compact Diamond from Brazil;* by M. Dufrenoy, (L'Institut, No. 792, March 7.)—Specimens of compact diamond have been found in the diamond deposits of Brazil. They have the same relation to the crystals as emery to sapphire. One fragment weighed 65·76 grammes; it had the appearance of a rolled pebble of a brownish color. Under the microscope it appears penetrated by numerous vacuities, separating small irregular lamellæ, slightly translucent, and irised in the sunlight. It cuts glass easily and scratches quartz and topaz. The specimens vary in specific gravity from 3·012 to 3·416, being differently porous. They undergo no change when treated in a crucible, showing that they include no vaporizable material. This result does not prove the igneous origin of these diamonds, but it renders probable the opinion suggested by Liebig, that they proceed from a transformation of vegetable organic matters. By combustion with oxygen they were found to consist of 96·84 to 99·10 of carbon, with 2·03 to 0·27 of ash, the latter being yellowish and appearing like ferruginous clay with some minute transparent crystals whose form was not determined.

2. *Phosphorescence of the Diamond;* by M. Reiss, (Rev. Sci. et Indust., xxiii, 185; Annuaire de Ch., 1847.)—The diamond phosphorescent by exposure to the sun, loses its phosphorescence rapidly when exposed to the red rays; and on the contrary, in the blue rays, it becomes most luminous in the dark.

3. *Examination of three new Mineralogical Species*, proposed by Prof. C. U. Shepard; by J. D. Whitney, (Jour. Bost. Nat. Hist. Soc., 1849, p. 42.)—The species here referred to are the Arkansite, Ozarkite and Schorlomite from Arkansas, described in this Journal, ii ser., vol. ii, 249, and iv, 279.

The *Arkansite*, according to the examinations of Mr. Whitney, is pure titanic acid, with only a trace of iron, (and not a *niobate* as inferred by Prof. Shepard,) and has the crystalline form and specific gravity of *Brookite*. His trials make the specific gravity 4·085. Its insolubility in acids is strong presumptive proof that it is not titanic acid in combination with a base, since all the known titanates are soluble in acids.

The *Schorlomite* was considered by Prof. S. a hydrous silicate of yttria, thorina and oxyd of iron. Mr. Whitney's analyses give the following results:

	I.	II.	III.
Silica, . .	27·89*	25·66	25·14
Oxyd of iron with a little manganese,	21·90	21·58	. .
Lime, . .	30·05	29·78	. .
Titanic acid, . .	20·43=100·27	22·10=99·12	. .

making it an *anhydrous silicate and titanate of lime and oxyd of iron*, having the formula $(\dot{Ca}^3\,\ddot{Si}+\dddot{Fe}\,\ddot{Si})+\dot{Ca}\,\ddot{Ti}^2$, the first part of

* Some of the titanic acid was not separated from the silica.

which is the formula of lime-iron garnet, a mineral with which it is associated. H = 6. G = 3·807. With the fluxes before the blowpipe, it affords beads colored with iron, and with soda a trace of manganese. The salt of phosphorus bead gives in the reducing flame the characteristic color of titanium, which is more distinct on the addition of tin.

Mr. Whitney proposes the new name *ferrotitanite* for the species, on the ground of an error in Prof. Shepard's analysis. But although there may be some reason for the change, the principle involved, if carried out with regard to the names of minerals generally, would create endless confusion in the science.

Ozarkite occurs only as a thin amorphous coating on elæolite. According to Prof. Shepard, it appears to be "a siliceous hydrate of lime and yttria, possibly also having traces of thorina."

Mr. Whitney states that a portion of the mineral as pure as could be separated, fused easily before the blowpipe, intumescing slightly like a zeolite and having a tendency to swell up with vermicular contortions like mesotype or scolecite. It also colored the flame yellow. It readily dissolved in acids to a clear liquid, and a quantitative examination showed it to be a hydrous silicate of alumina and lime, with a little soda, indicating, in connection with other characters, that it is probably a lime-mesotype or *scolecite*.

4. *Chemical Examination of some Minerals;* by J. D. Whitney, (Jour. Bost. Soc. Nat. Hist., 1849, p. 36.)—*Nemalite.*—This mineral is shown by the analysis of Mr. Whitney to be a fibrous variety of the hydrate of magnesia or Brucite. It afforded him magnesia 62·89, protoxyd of iron 4·65, carbonic acid 4·10, water 28·36. A small portion of magnesia is replaced by protoxyd of iron. The formula of Brucite ($\dot{M}g\,\ddot{H}$) requires magnesia 69·67, water 30·33.

Connel's recent analysis* is erroneous from the impurity of his specimen, in including a considerable proportion of carbonate of magnesia.

Coracite of Le Conte.†—An analysis of this mineral afforded:—silica 4·35, alumina 0·90, oxyd of iron 2·24, oxyd of uranium 59·30, oxyd of lead 5·36, lime 14·44, carbonic acid 7·47, water 4·64, magnesia and manganese *in traces* = 98·70. Mr. Whitney considers the uranium in the mineral as $\ddot{\dot{U}}$ (and not $\dot{U}\,\ddot{\dot{U}}$ as in common pitchblende) in consequence of its ready solubility in acids. The mineral occurs amorphous, with an uneven fracture and no trace of cleavage. Hardness = 3. Color pitch-black. Powder grey. Lustre resinous. Before the blowpipe it does not change its appearance or color the flame. With the fluxes it gives the characteristic reactions of uranium. In dilute muriatic acid it dissolves readily without heat, effervescing strongly, while pitchblende is insoluble except in nitric acid or aqua regia. The solution has a fine green color and contains a little flocky silica.

Pectolite and Stellite.—Pectolite occurs in Isle Royale, Lake Superior, in spheroidal masses, consisting of delicate silky fibres radiating from a centre, resembling foreign specimens from Monte Baldo. The stellite of Bergen Hill, New Jersey, analyzed by Beck, has the external characters of Pectolite, and also as Mr. Whitney shows, its composition. The following are the results of four analyses:

* See this Journal, iii, 265, 1847.

† See this Journal, iii, 173, 1847.

	Isle Royal.		Stellite of Bergen Hill.	
	I.	II.	III.	IV.
Silica,	53·45	55·66	54·00	55·00
Lime,	31·21	32·86	32·10	32·53
Soda,	7·37	7·31	8·89	9·72
Potash,	*trace.*	. .	*trace.*	. .
Alumina,	4·94	1·45	1·90	1·10
Water,	2·72	2·72	2·96	2·75
	99·69	100·00	99·85 J.S.K.	101·10 G.J.D.

Analysis III. was made under the direction of Mr. Whitney by Mr. J. S. Kendall, and IV, by Mr. G. J. Dickinson. The formula of von Kobell for pectolite is $3\dot{Na}\,\ddot{Si} + 4\dot{Ca}^3\,\ddot{Si}^2 + 3\dot{H}$.*

The Stellite of Thomson, Mr. Whitney observes, was probably impure Pectolite; and he refers Thomson's Wollastonite to the same species.

5. *On the Constitution of some Silicates containing Carbonic Acid, Chlorine and Sulphuric acid;* by J. D. Whitney, (Pogg. Ann. der Ph. und Ch., lxx, 431.)—Mr. Whitney in this paper gives the results of his examinations of the Sodalite and Cancrinite of Litchfield, Maine,† besides analyses of Nosean or Spinellane, Haüyne and Ittnerite.

The *Sodalite* occurs with elæolite in small cleavable masses of a sapphire blue color. The analyses afforded,

	I.	II.	Calculated.
Silica,	37·30	37·63	37·60
Alumina,	32·88	30·93	31·57
Peroxyd of iron,		1·08	
Soda,	23·86	25·48	25·47
Potash,	0·59	. .	. .
Chlorine,	6·97	. .	7·21

whence we have the formula, deduced by von Kobell,

$$\dot{Na}^3\,\ddot{Si} + 3\ddot{Al}\,\ddot{Si} + \dot{Na}\,\dot{Cl}.$$

The *Nosean* of Laacher See was found to contain:—Silica 36·52, alumina 29·54, peroxyd iron 0·44, lime 1·09, soda 23·12, chlorine 0·61, loss by heating 1·37, sulphuric acid 7·66; giving the formula,

$$\dot{Na}^3\,\ddot{Si} + 3\ddot{Al}\,\ddot{Si} + \dot{Na}\,\ddot{S}.$$

For the *Haüyne* from Albaner-gebirge, Mr. Whitney obtained:—Silica 32·44, alumina with a little water 27·75, lime 9·96, soda 14·24, potash 2·40, sulphuric acid 12·98=99·77. Formula,

$$\dot{Na}^3\,\ddot{Si} + 3\ddot{Al}\,\ddot{Si} + 2\dot{Ca}\,\ddot{S}.$$

* Mr. Whitney's researches confirm the opinion of the identity of these minerals, suggested in my System of Mineralogy, p. 336. Mr. A. A. Hayes, in his analysis of the Bergen mineral, there quoted, obtained for its composition, Silica 55·96, lime 35·12, soda 6·75, potash 0·60, alumina and magnesia 0·08, protoxyd of manganese 0·64, water (hygrometric?) 0·16 = 99·31. Frankenheim had stated that Pectolite contained no water; but Mr. Whitney's analyses confirm the results of von Kobell. —J. D. D.

† This Journal, 2d Ser., i, 119, 1846.

The mineral occurs in small druses with vesuvian, and has a clear greenish-blue color.

The Hauyne from Niedermendig afforded in one of his analyses, Silica 33·90, alumina 28·07, lime 7·50, soda 19·28, sulphuric acid 12·01 =100·76, with a trace of chlorine. No simple formula can be deduced from this result; but it corresponds quite well to a compound of 2 atoms of Hauyne and 1 of Nosean.

The *Cancrinite* occurs in hexagonal prisms, with lateral cleavage, and in columnar masses. The crystals have the hardness 5·5–6, specific gravity 2·448, and a citron or sulphur yellow color; the lustre inclines to greasy, except on a cleavage face which is vitreous. Transparent to translucent. Heated in a glass tube it gives off water and loses color immediately. In the forceps it fuses easily with effervescence to a colorless transparent blebby glass. With soda it effervesces and forms an opaque pearl, colored by manganese. With borax it forms freely a clear colorless glass. With salt of phosphorus it affords a clear pearl which becomes milky on cooling. With cobalt solution it gives a fine blue. The first of the three analyses, (which well agree,) afforded :—Silica 37·42, alumina 27·70, peroxyd of manganese 0·86, peroxyd of iron *a trace*, lime 3·91, soda 20·98, potash 0·67, chlorine *a trace*, carbonic acid and water 8·77=100·41. Including the water as an essential ingredient, Mr. Whitney deduces the formula,

$$\dot{Na}^2\,\ddot{Si} + 2\ddot{\mathbf{A}}l\,\ddot{Si} + (\dot{Na}^{\frac{1}{2}} + \dot{Ca}^{\frac{1}{2}})\ddot{C} + \dot{\mathbf{H}}.$$

The formula of foreign Cancrinite is $\dot{Na}^2\,\ddot{Si} + 2\,\ddot{\mathbf{A}}l\,\ddot{Si} + \dot{Ca}\,\ddot{C}$, and that of Stroganowite, (Hermann,) another silicate containing a carbonate, $(\dot{Na}^2, \dot{Ca}^2)\,\ddot{Si} + 2\ddot{\mathbf{A}}l\,\ddot{Si} + \dot{Ca}\,\ddot{C}$.

6. *Mineral Coal on the Nile*, (A. d'Abbadie in Athenæum, No. 1111, Feb. 10.)—Coal is reported to have been found on the banks of the Nile, near Asuan. The first vein, six feet thick, is one hundred feet below the surface. Still deeper is a second bed of only three feet thick, but of excellent quality.

7. *Mineral Coal of Vancouver's Island, North West America*, (Athenæum, No. 1110, Feb. 3.)—The Port of Camosack with its excellent harbor, promises to become of great importance, especially on account of the coal field of the northeastern district. The coal is worked so near the surface, that the Cormorant, steam sloop, was supplied by the natives with sixty-two tons of coal within three days. Specimens of this coal have been examined by the Admiralty; and although it yields a considerable percentage of ash, it is not much inferior to the coal of South Wales.

8. *Gold of Africa.*—According to St. Petersburgh papers, Col. Kavelooski, Director of the Mines of Siberia, at present engaged in a Mineralogical exploration of the interior of Africa, has found on the right bank of the Somat, a day's journey from Cassen, several large hills of auriferous sand, the washing of which is more productive than that of those of Siberia. Stimulated by this discovery, he pursued his examinations, and discovered similar tracks on the banks of the

Ramla, the Dys, the Goucka, the Benisch-Angol, and the Gamanil. It is stated that the Colonel was about to transport miners and gold-washers from Russia, to experiment in this field of his discovery on a large scale.—(*Athenæum.*)

9. *Vesuvius.*—In January last Vesuvius was singularly active, and two large streams of lava issued forth, taking the direction of Boscotrecase and Ottaiajano. After causing much fear and injury, the vents closed; but near the last of the month another stream burst out, down the east side, and threatened the villa of Prince Ottaiajano.

III. Zoology.

1. *New localities of Infusoria in the Tertiary of Maryland;* by Prof. J. W. Bailey.—The infusorial strata first discovered at Richmond, Virginia by Prof. W. B. Rogers, have been since noticed at so many places in Virginia and Maryland, that it is probable they will be found coextensive with the miocene tertiary of the United States. At present, however, the most southern *recorded* locality is the vicinity of Petersburg, Va., and the most northern is at Piscataway, Md. The examination of various specimens of earthy matter included in shells from the miocene tertiary of Maryland, collected by Francis Markoe, Esq., proves the existence of the infusorial strata in various parts of Calvert county, and removes the northern and eastern limit as far as now known, to Herring Bay, Ann Arundel county, on the Chesapeake. Specimens labelled "Marl from Herring Bay filled with water-worn shells, bones, sharks' teeth, &c.," yielded a considerable number of the well known Coscinodisci, Actinocycli, and other forms, constituting so large a proportion of the infusorial deposits. The same forms were found in considerable abundance in the clay containing Perna maxillata, from the vicinity of Huntington, Calvert county, Md., and other specimens labelled "Calvert Co." without mentioning the precise locality, were still richer in all the beautiful forms which belong to the deposit at Piscataway, Md. The infusorial strata being thus traced up to the western shore of the Chesapeake, they must now be looked for among the tertiary clays of Queen Anne county, Maryland, and Kent county, Delaware. A wide development of these beds is to be looked for in the Southern States, particularly in North and South Carolina, but no infusorial specimens from those states have yet reached us. The Polythalamian marls underlying the city of Charleston, South Carolina, are sometimes spoken of as infusorial, but they appear to be wholly made up of the calcareous shelled Polythalamiæ, without a trace of the siliceous shells of the infusoria.

2. *The Oyster.*—M. de Quatrefages has recently ascertained that, contrary to the common opinion, the sexes are separate in the oysters. M. Blanchard's observations confirm those of M. de Quatrefages. In his investigations into the nervous system of Mollusca, he has had occasion to examine a great number of these animals, and in the proper season, he has always found the eggs and the spermatozoa isolated in different individuals.

3. *New Discoveries of Bones of the Iguanodon;* by GIDEON ALGERNON MANTELL.—Dr. Mantell has recently published a Memoir on the structure of the Jaws and Teeth of the Iguanodon, illustrated by four large plates, giving views of the newly discovered jaw bones and of the teeth;*—and also a Review of the Organic Remains of the Wealden, in which the more striking peculiarities of these fossil bones are mentioned.* We here give a copy (reduced one-third lineally) of an inner view of the jaw from the former memoir. A full abstract of this memoir is given in vol. vi, p. 430, No. 18, for November, 1848.

EXPLANATION.

a. The coronal germ of the first anterior tooth, in its alveolus.

b. The crown of a successional tooth in its natural situation.

c. Portion of the base of a successional tooth. The above are visible in consequence of the removal of the inner parapet of the alveolar process.

d, d. The deep elongated *opercular furrow,* originally covered by the splenial or opercular bone.

e. An obtuse tubercle or projection forming the anterior termination of the symphysial portion of the jaw.

f, f, f. Denote some of the alveoli or sockets of the mature molar teeth.

m. The coronoid or complementary bone.

s. The articulating surface forming the symphysial suture.

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* From the Phil Trans. for 1848. Part II. p. 183–202.

† Quart. Jour. Geol. Soc., No. 17, Feb. 1, 1849, vol. v, p. 37.

4. *Additional Observations on the Osteology of the Iguanodon and Hylæosaurus;* by GIDEON ALGERNON MANTELL, Esq., L.L.D., F.R.S., Vice President of the Geological Society of London, &c., (Proceedings of the Royal Society, March, 1849. The Marquis of Northampton in the chair.)—This memoir, which is supplementary to the author's former communications to the Royal Society on the same subject, comprises an account of some important additions which he has lately made to his previous knowledge of the osteological structure of the colossal reptiles of the Wealden strata of the southeast of England.

The recent acquisition of some gigantic and well preserved vertebræ and bones of the extremities from the Isle of Wight, and of other instructive specimens from Sussex and Surrey, induced the author to resume his examination of the detached parts of the skeleton of the Wealden reptiles in the British Museum and in several private collections; and he states as the most important result of his investigations, the determination of the structure of the *vertebral column*, *pectoral arch*, and *anterior extremity* of the Iguanodon. In the laborious and difficult task of examining and comparing the numerous detached and in most instances mutilated bones of the spinal column, the author expresses his deep obligations to Dr. G. A. Melville,* whose careful and elaborate description of the vertebræ forms an appendix to the memoir. The most interesting fossil remains figured and described, are the following:—

Lower Jaw.—Since the author's memoir on the maxillary and dental organs of the Iguanodon,† he has discovered the right *ungular* bone; and from the circumstances under which this relic was found, he considers it probable that it belonged to the same individual as the teeth figured in the Philos. Transactions, for 1848.

Vertebral column.—The vertebræ hitherto assigned to the Iguanodon, consist of the middle and posterior dorsal and anterior caudal, as established by the Maidstone specimen in the British Museum; the cervical, anterior dorsal, lumbar, and posterior and terminal caudal, were previously either undetermined, or referred to other and distinct genera of saurians. The investigations of Dr. Melville and the author, have established the important and highly interesting fact, that the cervical and anterior dorsal vertebræ of the Iguanodon were *convexo-concave*—that is, convex in front and concave behind, as in the fossil genus termed *Streptospondylus*, and in the existing pachyderms. The convexity gradually diminishes and the anterior face of the vertebræ becomes flat in the middle and posterior part of the dorsal region. The supposed Streptospondylian vertebræ of the Wealden, referred by Professor Owen to a new species (*Strep. major*), are true cervical vertebræ of the Iguanodon. The convexo-concave type of vertebræ was not, in the opinion of the author, confined to a single genus—the Streptospondylus of the oolite—but was present in two, and probably in several genera of extinct saurians of the secondary geological epochs, in like manner as the reverse forms—the concavo-convex—prevail in the recent

* One of the authors of the Work on the Dodo, reviewed in this volume, p. 52.
† See preceding page.

Crocodilians and Lacertæ. Other large vertebræ found with bones of the extremities, ribs, &c., of the Iguanodon, and referred by Professor Owen to the genus *Cetiosaurus*, are regarded, in consequence of the peculiar structure of the neural arch, as belonging to the posterior dorsal or lumbar vertebræ of the former colossal reptile. Certain angular caudal vertebræ, also previously assigned to a species of Cetiosaurus, are considered by the authors as referable to the middle and distal regions of the tail of the enormous saurian, with whose bones of the extremities they are constantly found associated.

The Sacrum.—Several examples belonging to individuals of various sizes and age, are described. The sacrum is shown to consist of *six* anchylosed vertebræ, and not of *five* only, as stated by Professor Owen; and the typical specimen described by the latter eminent anatomist, was exhibited by Dr. Mantell in proof of this assertion. The anterior vertebra, and the two posterior vertebræ are much longer and stronger than the three intermediate elements that occupy the centre of the sacral arch.

Pectoral arch.—A perfect *scapula* or *omoplate* of the crocodilian type recently discovered in Tilgate Forest, and which corresponds with a coracoid bone formerly referred by the author to the Iguanodon, (Philos. Trans., 1841), is proved to belong to that reptile, from the remains of two similar scapulæ in the Maidstone specimen in the British Museum.* As the clavicals were already known, the essential elements of the pectoral arch of the Iguanodon are now for the first time ascertained; and the author gives a restored figure of this important part of the skeleton.

The Humerus or arm-bone.—A humerus three feet long, found in the Isle of Wight, has been ascertained by Dr. Mantell to belong to the Iguanodon, from its entire correspondence with a bone in the Maidstone fossil, previously undetermined. This last bone, from its disparity in size in comparison with the femur—being one-third shorter—was formerly assigned to the fore-arm, but the fossil from the Isle of Wight enabled the author to ascertain its true place in the skeleton. It now appears that in the Iguanodon, as in many fossil and recent reptiles, the anterior extremities were shorter and less bulky than the posterior. The *radius* and *ulna* are still unknown, but the author conceives that certain imperfect bones in his former collection (now in the British Museum), are those of the fore-arm.

Hinder extremities.—The colossal magnitude of the Iguanodon is strikingly shown by some thigh and leg-bones recently discovered in the Isle of Wight. A *femur* or thigh bone is four feet eight inches long; and a *tibia* or leg-bone four feet long.

Dermal scutes and Spines.—The author figures and describes several dermal scutes and spines, and states that a microscopical examination of the large angular bones of the Hylæosaurus† supposed by him to be ossified dermal spines, but which Professor Owen regarded as more probably referable to the abdominal ribs, proves the correctness of his own opinion, for their structure is identical with that of the indisputable dermal scutes.

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* Figured in Dr. Mantell's Wonders of Geology.

† See a figure in Dr. Mantell's Medals of Creation.

In the summary which concludes this important memoir, Dr. Mantell states that the parts described confirm in every essential feature the physiological inferences relating to the structures and habits of the Iguanodon and Hylæosaurus enumerated in his former communications; and thus after the lapse of a quarter of a century he concludes his attempts to reconstruct the skeleton of one of the most extraordinary Saurian herbivores that has trod the dry land of our planet, and of whose former existence a few waterworn teeth and bones were the only indications, when in 1825 he laid before the Royal Society the first notice of a newly discovered herbivorous reptile from the strata of Tilgate Forest.

The memoir was illustrated by numerous drawings and diagrams, and the table of the library of the Royal Society was covered with the unique and highly interesting fossils described in the communication.

5. *Fossil Squalidæ of the United States;* by R. W. Gibbes, M.D., (Jour. Acad. Nat. Sci. Philad., July, 1848, and Jan., 1849.)—These two valuable memoirs by Dr. Gibbes, are very fully illustrated by excellent lithographic quarto plates, (the first by four, and the second by three,) including in all, nearly two hundred figures. The collections of the author are peculiarly rich in the teeth of the Squalidæ from the tertiary beds of South Carolina.

The following is a list of the species and varieties described and figured;—for the descriptions we must refer to the memoirs themselves.

1. *Teeth with crenated edges.*

Genus Carcharodon. C. megalodon (*Agas.*), *var.* rectidens, and subauriculatus; angustidens (*Ag.*), *var.* lanceolatus, heterodon, megalotis, ariculatus, turgidus, semiserratus, toliapicus, acutidens, Mortoni, lanciformis, sulcidens.

Genus Galeocerdo. G. aduncus (*Ag.*), latidens (*Ag.*), minor (*Ag.*), Egertoni (*Ag.*), pristodontus (*Ag.*), contortus (*Gibbes*).

Genus Hemipristis. H. serra (*Ag.*)

Genus Glyphis. G. subulata (*Gibbes.*)

Genus Sphyrna. S. prisca (*Ag.*), lata (*Ag.*), denticulata (*Ag.*)

Genus Notidanus. N. primigenius (*Ag.*)

2. *Teeth with smooth edges.*

Genus Lamna. L. elegans (*Ag.*), cuspidata (*Ag.*), compressa (*Ag.*), acuminata (*Ag.*), crassidens (*Ag.*), contortidens (*Ag.*), Hopei (*Ag.*), verticalis (*Ag.*), gracilis (*Ag.*)

Genus Otodus. O. obliquus (*Ag.*), appendiculatus (*Ag.*), levis (*Gibbes*), crassus (*Ag.*), macrotus (*Ag.*), trigonatus (*Ag.*), apiculatus (*Ag.*)

Genus Oxyrhina. O. hastalis (*Ag.*), xiphodon (*Ag.*), plicatilis (*Ag.*), Mantelli (*Ag.*), crassa (*Ag.*), minuta (*Ag.*), Sillimani (*Gibbes*), Desorii (*Gibbes*), Wilsonii (*Gibbes.*)

The monograph is to be continued from time to time as specimens are procured.

IV. Astronomy.

1. *Le Verrier's Further Vindication of his predicted theory of Neptune.*—In my communication of the 11th of September last, I showed that the differences between the predicted elements of Neptune, and those which result from observation are inconsiderable. I now propose to go farther into the question, and to prove that all these differences are within the limits which the uncertainty of the data will allow. The discussion will thus terminate with those who seek only for the light. They will reflect, that when an author has brought forth from the data of a question all that is therein contained, nothing more can be asked of him; and that the more uncertain the data, the more difficult is it to bring out the truth.

It will be impossible for me to give, in this recapitulation, more than the results of the calculations which served me a basis. These calculations being very extended, I ought simply to lay them before you as matters of demonstration. But nothing would be more agreeable to me than to give conscientiously to each, all the scientific explanations conscientiously asked.

I. I take up first, the comparison of the true longitude of Neptune, as deduced from my theory, with that which results from the orbit calculated by Mr. Walker, from the position of 1795, and upon the observations made during the two last years. This comparison furnishes:

	True longitude in the predicted orbit.	True longitude in the orbit of Walker.	Difference.
In 1887 . .	396°·9	415°·5	18°·6
1877 . .	380 ·9	393 ·6	12 ·7
1867 . .	363 ·9	371 ·6	7 ·7
1857 . .	345 ·7	349 ·7	4 ·0
1847 . .	326 ·5	327 ·5	1 ·0
1837 . .	306 ·4	305 ·7	− 0 ·7
1827 . .	285 ·9	283 ·9	− 2 ·0
1817 . .	265 ·3	262 ·2	− 3 ·1
1807 . .	245 ·2	240 ·7	− 4 ·5
1797 . .	225 ·9	219 ·3	− 6 ·6
1787 . .	207 ·6	198 ·0	− 9 ·6
1777 . .	190 ·4	176 ·7	−13 ·7
1767 . .	174 ·3	155 ·5	−18 ·8

The question is, are these differences, thus *rigorously* calculated for 120 years, practically less than those which the *uncertainty of the data* would and ought to introduce, at one epoch or another.

First of all, let us understand well, the signification of this expression, *uncertainty of the data;* an expression which has too often, through misapprehension, been taken for *uncertainty of the observations.* If any one will read the 239th page of the memoir published in 1846, he will see that such a substitution of terms was not allowable.

I will here explain, that the *uncertainty of the data*, results not only from the *uncertainty of the observations*, but also from two other causes, viz: 1st, from the possible inaccuracy in the mass of Saturn which may increase the uncertainty of observation 3″: and second, from the influence of a planet situated beyond Neptune, whose effect on Uranus,

it is easy to see, would amount to from 5″ to 7″. Combining the possible effects of these three causes, there results, as I have already explained, in 1846, the *uncertainty of the data.* It may fully amount to 10″ or 12″, although the *uncertainty* of modern *observations* is not greater than 2″ or 3″.

And after having added, in the same memoir, that the magnitude of the discrepancies which might be allowed between observation and calculation, is thus indeterminate, I fixed it arbitrarily at 5″ for all the positions of Uranus observed from 1781 to 1845. It is on this *arbitrary* hypothesis that I have made my calculations of limits. But it will be seen, and should not be forgotten, that instead of 5″, I could have taken 10″ and even 12″.

All this being granted, if any one will completely develope the numerical calculations of my theory of limits, a brief synopsis of which I have given in the memoir of 1846, it will be found, *even reducing the uncertainty of the modern data to* 5″, that during 120 years which I have compared as above, the differences of the longitudes of Neptune in my predicted orbit and in the orbit of Walker, are always within the uncertainty of the data. It is the same whether before or after these 120 years. But I confine myself to the consideration of this period —sufficiently long however—because I can, in regard to it, support myself upon the *Compte Rendu* of the 31st of August, 1846, and upon my complete memoir published in the *Connaissance des Temps.*

I showed, the 31st of August, 1846, before the discovery of Neptune, that it might be necessary to push the search 18°·5 beyond the position which I had assigned as the most probable. I printed it anew after the discovery of the body.

Thus, since 1846, I have acknowledged that the uncertainty of the data might cause an uncertainty of more than 18 degrees in the place of the planet, at one of the epochs when we could best answer for its position. It is evident that the discordance in the longitude calculated by my theory, has never been, during 120 years, equal to that which I considered in 1846 as possible. Upon which I ought to remark:

1st. It is proved that, whether before the discovery of Neptune, or after that discovery in 1846, or at the present day, I have always held the same language relative to the uncertainties in the results, produced by the uncertainty of the data.

2d. The orbit calculated by Mr. Walker upon the position taken in 1795, and upon the whole of the small arc observed since the discovery, may very possibly be in error many degrees, either in 1887 or 1757; and that, if I have admitted as exact, the positions which it furnishes at these epochs, it was only through courtesy, and because it was no embarrassment to me.

3d. Although the discordance of my theory might be 18°·5, in 1846, without furnishing occasion for complaint, yet the real discordance is found to be much less, and has never exceeded 3°·7 during the period in which the perturbations were sensible. This is a point upon which I insist in a very particular manner, and I pray that it may receive some attention.

II. I shall be brief upon the distance from the sun, because it is virtually comprised in the elements of the ellipse, which I shall consider

in detail. My orbit gives 33·0 for the distance of Neptune from the sun at the time of discovery.

The orbit of Walker gives 30·1 for the distance from the sun at the same period.

Now in reducing to numbers my theory of limits, I find, *without supposing the uncertainty of the modern data greater than* 5″, that the theory of Uranus would be satisfied, if a planet were situated at any distance from the sun comprised between the limits 29·6 and 35·2. The two numbers above mentioned are really contained between these limits.

I pass to the elements of the ellipse themselves, elements which I did not directly consider in my first discussion, but in which they are found to be virtually contained. The elements, I have said to the Academy, are only mathematical *auxiliaries*, suited to lead to the knowledge of the direction and distance; these auxiliaries might vary considerably, without failing to give the position of the disturbing body at the epochs of the perturbations.

I did not then know that foreign astronomers would be so ready to send me declarations conforming to those of my illustrious brethren, Messrs. Biot, Cauchy and Faye; and that among these testimonies would be found a thorough discussion of the question, signed *Herschel;* a discussion superior to any that could emanate from my pen, and whose publication would have been my only defense, had I then possessed it, and if even at the present time I am not in haste to reveal it to the friends of science, they will not reproach me when I inform them that this illustrious English Astronomer is engaged in putting in a clear light all the scientific points of this discussion with the intention of soon publishing the result of his researches.

I give meanwhile the following extract from the letter of Herschel.

"The elements are *intellectual objects*, suited to represent to the mind the general relations of the planet with time and space, while the direct object of your efforts was to say where the disturbing body was placed at the epoch of the research, and where it was during the forty or fifty years preceding. Now it is this which you have made known with perfect accuracy."

These remarks being made let us consider the elements.

III. *Longitude of the perihelion.*—I assigned 284°·8 for the longitude of the perihelion of Neptune.

Mr. Walker gives 360°·2 for the longitude at the same epoch. The difference, 75°·4, it is said, is enormous, and without doubt it is. But the question is, to know if the uncertainty of the data authorizes this difference.

In reducing to numbers my theory of limits, *without carrying the uncertainty of the modern data beyond* 5″, I find that the perihelion may be placed at any distance between 229°·9 and 366°·4.

The numbers 284·8 and 360·2 are both within these limits.

IV. *Mean Longitude.*—This element is variable with the time. Whatever may be the epoch to which it is referred, the same results will necessarily follow. Let us take the epoch of January 1st, 1847.

I have given in my memoir 318°·8 for the mean longitude.

Mr. Walker finds 328°·1.

My method assigns for the limits of this element 310°·5 and 335°·6, always taking but 5″ for the uncertainty of the modern data.

The number of Mr. Walker, and my own, are within these limits.

V. *Eccentricity.*—I have given 0·1076 as the value of this element, whilst that of Mr. Walker is only 0·0088.

The discordance may appear considerable to those who know not how ill determined are the eccentricity and major axis of an ellipse from even a considerable portion of the curve known, as will be seen in the two ellipses of *gamma* Virginis. But all embarrassment vanishes when we take the trouble to calculate the limits of uncertainty of the eccentricity, corresponding to the limits of uncertainty of the data.

It is actually found, in admitting only 5″ of uncertainty, *in the modern data*, that the eccentricity of the body causing the irregularities of Uranus may be arbitrarily chosen between 0·2031 and 0·0592; limits already much extended, and which explain why the eccentricity of Neptune was determined so poorly, by its action on Uranus. But more, we have only to carry the uncertainty of the modern data to 7″ or 8″ as may properly be done, to see that the inferior limit of eccentricity falls nearly to zero, and the superior limit is raised to 0·25, or even higher. Thus the eccentricities given by my theory and by the orbit of Mr. Walker come completely within those which are authorized by the uncertainty of the modern data.

The eccentricity, I repeat, is but a mathematical *auxiliary;* and it is not by such auxiliaries that the degree of precision of a theory must be judged. They may vary very much, as we see, without the final result, which is here the longitude, experiencing any remarkable variations. I have often had occasion to show the Academy, how changes, almost insignificant, in the positions (deduced from direct observations) which have served to determine the elements of a comet or planet, have produced considerable changes in the values of the elements.

By fitly choosing the auxiliaries, and comparing them without knowing their signification, we could, *in appearance*, spoil any theory whatever. What an enormous discordance there seems, at first sight, between two theories in which the tangents of the same angle are represented by the numbers 206265 and 344. And yet on referring to the angles themselves, that is to say, to the direct object of the question, it will be found that they differ but *ten minutes*.

VI. *Semi-axis major.*—The semi-axis major gives occasion for the same remarks as the eccentricity. There has been thought to be an insurmountable difficulty, in what I have said, (page 240 of the memoir of 1846,) viz., that the semi-axis major was contained between the limits 37·90 and 35·04, while Mr. Walker makes it 30·20.

I do not believe, to tell the truth, that the direct observations of Neptune, which we have at the two ends of an arc one hundred degrees in length, are sufficient for a good determination of the semi-axis major of the orbit. But I have said that I will not contest this point.

The solution of the pretended difficulty lies wholly in the fact, that the limits 37·90 and 35·04 *are not absolute limits*, but limits relative to the *arbitrary* hypothesis that the modern data do not allow of a greater uncertainty than 5″. It will not be forgotten that I explained on the

239th page of the memoir already cited, that this uncertainty might be much greater, and amount even to 10″ or 12″, *as is the case in the tables of Saturn and Jupiter*, and as I have exhibited above.

When we re-calculate the limits of the semi-axis major with other uncertainties than 5″ in the data, we see that it is a great error to suppose the extent of the limits of the semi-axis major varies proportionally to the uncertainty of the data. It varies much more rapidly. Thus, although for 5″ of uncertainty in the data we find an interval of 2·86 between the limits of the semi-axis major, this interval so diminishes with the uncertainty of the data, that when we reduce it to one half, we find no value of the semi-axis major whatever that can satisfy the question. And on the contrary when we carry the uncertainty of the modern data above 5″ we see that the lower and higher limits of the major axis change rapidly, and leave a great latitude in the choice of this auxiliary. "Without doubt," says Sir J. Herschel, "we may take for the starting point any value for the semi-axis major comprised between 30 and 38." It is not necessary to consider the period of revolution separately, since it depends solely on the semi-axis major. But it is proper to consider here another difficulty which has been supposed to exist in the fact, that with the semi-axis major 30·20 the period of revolution of Neptune should be very nearly double that of Uranus; a circumstance which would introduce in the theories of these two planets, irregularities of considerable magnitude. *It is a difficulty only of form*, says Sir J. Herschel with propriety, in his letter. And in fact so far from these great irregularities being an embarrassment, we may neglect them for a period of time equal to that which I have considered. I have given the reason on page 157 of my memoir. In the inequalities of the form A sin $(\alpha t+\beta)$, α is a very small angle, so that in the limits wherein the time is comprised, we may substitute sin $(\alpha t+\beta)$ for a progressive convergent series, according to the powers of the times, and limited to the two first terms. Now these terms are confounded with the mean longitude of the elliptical part of the movement of the disturbed body, and may therefore be neglected in the calculation of the perturbations.

It is a serious error to suppose that the *absolute values of the perturbations*, at a given epoch, can serve to determine the position of the troubling body which produces them. We can only make use of the variations which these perturbations experience, with the times, and yet, must reject the part proportional to the times. The analytical formulæ which we employ to represent the position of the troubling body, ought to satisfy only the condition of furnishing, during the interval of time in which the perturbations are sensible, the same second differences of the perturbations, that are obtained by quadratures, when we know beforehand the geometrical situations of the disturbing body and its mass.

VII. *Mass.*—The mass of Neptune deduced from the observation of its satellite is, according to Mr. Struve, 0·65 of the mass which results from my theory; the extremest valuations reduce this down to 0·52 of this mass.

Now my theory of limits shows that an uncertainty of only 5″ in the modern data, allows of the adoption of a mass *more than twice* as

great as the one I have given, as also a mass which may be but 0·63 of the same. And in order to have a mass but half of that which I have given, we need only to carry the uncertainty of the modern data to 7″·4. This therefore presents no difficulty.

To recapitulate :—

I announced in 1846, that on a given day, might be found in a given place, a planet that would account for the perturbations of Uranus. And the astronomers of Berlin found on the day, and in the place indicated, a planet which does account for the perturbations of Uranus.

This coincidence was not accidental. Suppose I were to-day, Oct. 2d, 1848, to make known to the Academy, for the first time, my work, and having deduced the place where we ought to look for the planet this evening, we should immediately discover the body, at a distance less than *a degree and a half* from the position we would have thus assigned it. The prediction would have been equally exact in 1837 or 1827. At any epoch an observer would have found the planet within the limits which my calculation assigned it; and during 120 years these limits have not exceeded those which I gave even in 1846; limits which were printed before the discovery, in our *Comptes Rendus*, and after the discovery of the body in the *Connaissance des Temps*.

It results in short, from my theory of limits, the exposition of which I have given on pages 239–249 of the memoir of 1846, that the elements of Neptune deduced from observation, do not differ from the predicted elements more than the uncertainty of the data authorizes. The proof is unanswerable.

Among the periodical comets recently discovered, there is not perhaps one, the theory of which, founded upon actual observations made during one appearance, would give, after sixty years, the longitude with as much certainty and precision as I have obtained.

Allow me to speak with freedom. When I announced my principal result in 1846, I found scarcely a person who would believe it. Deduce the position of a planet from a little derangement which it caused in Uranus! What folly! it was said. But those who spoke thus, are precisely the ones, who, at the present day, find it altogether intolerable, that I have not succeeded in giving the position of Neptune for eighty years, without an error of more than $7\frac{1}{2}°$ at the end of this period, and who think the world ought to make a severe example of me.—*Comptes Rendus Acad. Sci., Paris, October 2d*, 1848.

2. *Indication of a Method of testing Olbers's Theory respecting the common origin of the small Planets;* by S. Alexander, (from Nos. 658 and 659, of the Astronomische Nachrichten; communicated for this Journal by the author.)—Since the discovery of so many new planets in the region between Mars and Jupiter, the hypothesis of Olbers with respect to their origin has, of course, received renewed attention. Any thing which may have a tendency to confirm or to refute that hypothesis cannot fail to be of interest. I would therefore respectfully propose a mode of investigation which, if successful, might afford a plausible confirmation of the hypothesis of the explosion of a single planet in the region in question, or else show, with an equal plausibility, that no such event could have occurred.

The computation of the paths of the fragments, immediately subsequent to the rupture, must, at present, be regarded as beyond the reach of analysis; but the mass of the planet being small, the mutual perturbations of its fragments must soon have been quite inconsiderable. When this state of things was attained, the nodes of the orbits then to be described may yet have been very nearly together; viz., the nodes of the orbits of the several fragments as marked upon the orbit of the original planet, or the nodes of all the fragments but one, as marked upon the orbit of that excepted one. At the same time the respective distances of the several fragments from the sun must all have been very nearly equal.

It becomes us then to inquire, how nearly the data which we at present possess, or may yet acquire, will enable us, by computation backward, to arrive at an indication of this state of things.

Now the masses being all insignificant, it would seem that the *secular motions* of the nodes of the several orbits upon the ecliptic (or that of the nodes of all the orbits but one counted upon the orbit of that excepted one) as well as the motions of the lines of apsides, might all be very accurately determined.

Should the algebraical differences of the motions of the nodes, thus found, indicate a near approach of all the nodes at some former period, this would itself be an indication of the common origin of the planets in question; and the time at which the nearest approach was found to have occurred, would also be the latest date which could be assigned to the rupture of the original planet.

All this would be confirmed, if the secular motions of the major axes of the several orbits should also indicate such a position of them, that the distances of the several planets from the sun should, at the date thus obtained, be nearly the same.

The orbits of all the planets being movable, it would be preferable to refer the intersections of the orbits in question to a fixed plane suitably situated, and compute the motion of the points of intersection in that plane. For the suggestion of this modification I am indebted to Prof. Peirce, of Harvard University, to whom, in conversation, I communicated the plan here described.

In the close approach of the nodes, the confirmation of the hypothesis in question does not require that all the nodes thus brought into the neighborhood of each other, should be of the same description; viz., all ascending, or else, all descending nodes. On the contrary the confirmation would be the greater, if the result should be different. That such would prove to be the fact, if the approximation were found to have occurred at all, seems to be foreshadowed by the present position (on the ecliptic) of the descending node of Iris, in the region of the ascending nodes of the others.

As before remarked, the period of nearest approach in question will furnish the latest date which we can fix upon for the rupture of the original planet. For it is quite evident that several revolutions of the nodes may have occurred since that event, if it really happened. The approach to an equality of distances, as indicated at the same time, by the requisite changes in the positions of the major axes of the orbits, would in any case, indicate the date, with great probability.

Should the whole investigation indicate no tendency to such an approach of the nodes as has been described, we should have reason to conclude, that the hypothesis of a common origin of the planets in question, in the way supposed, is untrue.

3. *New Comet.*—On Wednesday evening, April 11, 1849, a telescopic comet was discovered near the *Northern Crown*, by Mr. Geo. P. Bond, at the Cambridge (Mass.) Observatory; this being the eighth comet discovered by him before any information thereof had reached this country.

The following places (referred to the mean Equinox of Jan. 1, 1849) were obtained at the Cambridge Observatory.

	Camb. m. t.	A. R.	Decl. N.
1849, Apr. 11,	$10^h\ 56^m\ 29^s$	$15^h\ 9^m\ 6^s{\cdot}11$	28 38 27·
12,	7 57 58	15 3 36 ·28	28 20 9·1
14,	10 35 59	14 48 12 ·14	27 36 33·7
17,	8 48 52	14 20 40 ·60	25 54 23·4

It has a strong, star-like central condensation, an extensive coma and no tail, and was seen on the evening of April 17 by the naked eye.

V. Miscellaneous Intelligence.

1. *On Meteoric Iron in South Carolina;* by Charles Upham Shepard. (Communicated for this Journal.)—For my first knowledge of this meteorite, I am indebted to a letter from Dr. E. H. Andrews, of N. C., dated Concord, January 16th, 1849, in which he observes that he had just been handed two or three pounds of iron, said to have been detached from a larger mass, ploughed up in a field. At my request, Dr. Andrews proceeded to the place, with a view to ascertain the facts in the case. His letter of February 3d, from Chesterville, Chester District, South Carolina, is as follows: "I received yours of the 30th ult., and the next morning came down to this place, in search of the meteoric mass and the facts relating to it, which I find to be these. It was found several years since by a laborer, on the plantation of Mr. Samuel M. McKeown, which is situated about six and a half miles below this place, on the Columbia road. His first impression on ploughing it up, was, that it was the common mountain ore of the region; but observing that it was exceedingly heavy for its size, he took it to the house, where, however, it excited no particular attention, and was accordingly suffered to remain behind an out-building until very recently, when the finder had the curiosity to take it to the blacksmith, who at once proved it to be malleable. He cut several pieces from the mass, out of which he made horse-shoes, nails and hinges for a gate. The original weight of the mass was thirty-six pounds. It has been reduced about one half, and the unworked portion is now in the possession of Dr. Wm. D. Kersh, of Fairfield District.

Its original shape is described as having been oblong, with one side and end thicker and rounder than their opposites; or as possessing the form of a common fresh water muscle (a species of Unio). Its surface was much indented and coated by rust.

I have since received specimens of the mass (two of which were in a wrought condition) obtained by Dr. A., together with the larger piece

also referred to, as being in the possession of Dr. Kersh, abstracts of whose correspondence, as well as a letter from Mr. McKeown, will be presented hereafter in my description of this iron.

I have already ascertained that it contains about 5 p. c. of nickel, besides traces of chromium, cobalt, and nodular masses of magnetic pyrites, which latter substance, when dissolved, exhibits fine, but very brilliant scales of plumbago.

Its most remarkable peculiarity consists in the appearance of its polished surfaces when treated with dilute nitric acid. In one spot, it then shows scattered, but distinct characters, resembling Chinese letters; in another at wide intervals, a series of short, straight lines, with square ends, precisely like dashes in printing; again the brilliant markings are arranged across an uniform ground, so as to simulate the course of a river on a map, or the meshes of a cobweb. The spaces between the raised lines above described are filled up with shining points and fine Widmannstättian figures, presenting on the whole, a surface strikingly similar to that produced in silver when cooled from fusion. It is very dense, and takes a brilliant polish; but its etched surface immediately distinguishes it from every other iron hitherto described.

2. *Staite's Electric Light.*—We have just received in the Mechanics Magazine, the specification in full of Mr. Staite's patented improvements in the production of galvanic light for illumination.

The question of the economical and successful application of galvanic light to the purposes of general illumination, has of late excited considerable interest, and some brief notices of Mr. Staite's labors on this subject have already appeared in the public prints.

One of the principal difficulties in the way, has been the inconstancy of the light of the carbon points or electrodes used, in consequence of the variations in the strength of the current. This difficulty Mr. Staite has endeavored to overcome, how successfully remains to be seen, by means of mechanism for regulating the interval between the carbon points. This he has done in various ways, one of which, we believe, was specified in a former patent granted in July, 1837. One of the simplest specified in the present patent, and that by which we can best illustrate the operation of the others, consists in connecting the lower or negative carbon point or electrode with an iron rod or bar moving vertically in a coil of wire, through which the galvanic current is made to circulate. The iron rod rises by a counterpoise till it brings the carbon point connected with it, into contact with a fixed carbon point above, when the current instantly passes and the coil acts on the iron rod and draws it down and thus separates the two points, and continues to separate them until the current is reduced to a standard quantity, determined by the weight of the counterpoise. If the current begins to fail, the diminished action of the coil allows the counterpoise to bring the points nearer together; if the points approach too near, the current becoming stronger immediately separates them again. To prevent injurious vibrations or sudden movements of the iron rod, it is furnished with a rack, wheel work and fly.

Another improvement consists in giving the upper electrode the form of a circular disc, made to revolve slowly in contact with a fixed scraper which keeps the edge of the disc clean and free from the particles of carbon projected upon it from the lower electrode.

A further and important feature in this patent is the mode specified of preparing the carbon for electrodes, which consists in general in forming powder of charcoal or other suitable form of carbon into a paste, with melted brown sugar, pressing it into iron moulds and baking it in the moulds at a red heat, and afterwards in a crucible at a white heat.

For the form of light in which an ignited platinum wire or foil has hitherto been used, Mr. Staite claims introducing the use of iridium as the hardest and most refractory of the metals; but we doubt whether light produced by the ignition of metallic conductors can be economically used.

We have not room for a description in the present number of the construction of the batteries used and the materials employed in working them. The objects aimed at are economy, convenience, constancy of action, and complete consumption of material.

Whether Mr. Staite's labors have been entirely successful or not, we cannot believe the brilliant light of the galvanic arc is to be forever confined to the laboratory and lecture room of the chemist. If the difficulties hitherto incident to its use can be overcome, and we see no reason why they may not be, there can be little doubt that this may be made the most economical as it is the most powerful source of artificial light known to us.

3. *The Anniversary of the Geological Society for* 1849, *held in London.*—Among the distinguished persons present were the Archbishop of Canterbury, Sir Robert Peel, the Belgian Ambassador, Sir R. I. Murchison, Sir H. De la Beche, Dr. Buckland, Dean of Westminster, and most of the great men of the metropolis. Sir Charles Lyell, the new president, took the chair.

The Archbishop made an admirable speech in defense of scientific pursuits, and of geological researches in particular, and Sir Robert Peel ably sustained similar views,—followed by Dr. Buckland; and Prof. Sedgwick poured forth a flood of unrivalled eloquence. The Belgian Ambassador in capital English, with just sufficient foreign accent to add to its interest, gave a luminous address in praise of science, and a just encomium on his own country, for having remained unmoved in the midst of the revolutionary debacle which has swept over the continent.

Sir R. I. Murchison made a courtly speech complimentary to the nobles present. Sir C. Lyell spoke with his usual good sense, and Dr. Mantell as one of the Vice-presidents made a responsive address. Sir H. De la Beche, has been a capital president, and his address was excellent. The Wollaston medal was awarded to Mr. Prestwick, for his various papers on the tertiary strata of the London and Hampshire basin.

Obituary.

4. Edward Forster, Esq., Vice President of the Linnæan Society, in the 84th year of his age.

5. M. Hommaire de Hell.—This French naturalist died at Ispahan, while on a scientific mission in Persia, under the direction of the French government. M. de Hell was scarcely thirty-four years of age.

6. Dr. GEORGE FOWNES.—Dr. Fownes, Professor of Practical Chemistry, at University College, London, has recently died at the age of 34. He is the author of an excellent Manual of Chemistry, which has been reprinted in this country.

7. Dr. PRICHARD, (Ath., No. 1108, p. 70.)—Ethnological science has recently sustained a serious loss by the death of Dr. Prichard. He was well known by his great work "Researches into the Physical History of Man," in five volumes,—and his yet more popular "Natural History of Man." In addition to these, he was the author of "An Essay on the Vital Principle," a treatise on "Insanity," a book "On the Eastern Origin of the Celtic Language," and many other works and essays which appeared in the medical journals. At the time of his death, Dr. Prichard was president of the Ethnological Society.

VI. BIBLIOGRAPHY.

1. *Botanical Collections in New Mexico, and in the Rocky Mountains.*—The first part of the Account of the Collection of Plants made in New Mexico by Mr. Fendler, with descriptions of the new species, critical remarks, and characters of other undescribed or little known plants from surrounding regions, is printed as the first article of the fourth volume (new series) of the Memoirs of the American Academy, now in press; and separate copies (of one hundred and sixteen pages, quarto) are distributed to the subscribers to Fendler's collections. We wish to solicit further encouragement to this adventurous explorer, in the way of subscriptions to his collections. Several sets of the Santa Fe collection, in specimens of unrivaled beauty and completeness, are still in the hands of Dr. Gray, at Cambridge, and of Mr. Heward at London, who may be applied to for them. Mr. Fendler is now on his way to explore the great interior basin between the Sierra Nevada of California, and the Rocky Mountains, especially around the Great Salt Lake, the Utah Lake, and the adjacent mountains. The collections are to be studied and distributed by Dr. Gray and by Dr. Engelmann, to whom those desirous to subscribe for them should apply, and will be issued at the same price as the Santa Fe collection, namely at ten dollars per hundred specimens.

In order that the botany of New Mexico should be further made known, particularly of the southern portion, Mr. Charles Wright is now on his way from Texas across to El Paso on the Rio del Norte, a little below lat. 32°, in the vicinity of which, and especially in the mountains east and west of the valley, he will collect during the present season; and the following year he proposes to extend his explorations, as opportunities offer, into other parts of the country, yet untrodden by botanists. Sets of the plants he may collect will be offered to subscribers, in the order of their application, at the same price as those of Fendler. A. GR.

2. *Hooker's London Journal of Botany and Kew Garden Miscellany.*—This is the title of a new series of Hooker's Journal of Botany which commenced at the beginning of the present year. It appears that there were not subscribers enough to sustain a single Botanical Journal of the kind; and the attempt is now made to secure an ade-

quate support by reducing the amount of the text and plates and lowering the price. The monthly numbers of the new series therefore consist of thirty-two pages and one plate each, instead of fifty-four pages and two plates, and the price is reduced to *one shilling* per number. Not only are the labors of the editor and the drawings furnished gratuitously to the publishers, but, if we are rightly informed, the editor pays for his own copy besides! It will indeed be a national shame if this excellent journal is not properly sustained at this cheap-literature price, after such sacrifices have been made in its behalf. There ought to be many subscribers in this country, especially since under the new postal arrangement, copies may be sent by mail direct from London to any part of the United States at a moderate rate of postage. The publishers are Reeve, Benham & Reeve, now the most active scientific publishers in Great Britain, and who have for the past two years published the London Journal of Botany, of which this is a continuation of equal interest and importance. The contents of the numbers for January, February, and March are as follows:—

Contents of No. 1.—Dr. Hooker's Botanical Mission to India (*with a plate*)—Dr. Broomfield's Notes on the Botany of the United States—Mr. Spruce's Voyage to the Amazon River—A new Esculent Nut—Patchouly plant—Jute Fibre—Chinese Grass Cloth—Pooah fibre of Nepal—Oadal fibre—Fibre of *Sterculia guttata*—*Musa textilis* or Manilla hemp—Dr. Hooker's Rhododendrons of the Sikkim Himalaya—Walper's Annals of Systematic Botany—Weddell on the genus *Cinchona*—Hertfordshire Flora—Moore's British Ferns—Port Natal Herbarium.

Contents of No. 2.—Professor Henslow on the Awns of Nepaul Barley (*with a plate*)—Dr. Hooker's Botanical Mission to India—Major Madden, on the Botany, &c., of the Turaee and outer Mountains of Kumaoon—M. Bourgeaud's intended Botanical excursion in Spain—Fendler's collection of Plants of New Mexico—The late Dr. Taylor's Herbarium—Prof. Lehmann's critical revision of the genus *Potentilla*, and the Flora of South Africa—Botanical Appendix to Captain Sturt's Expedition into Central Australia.

Contents of No. 3.—On the genus *Triguera* of Cavanilles; by John Miers, Esq., F.R.S., F.L.S.—Dr. Thomson's Scientific Mission to Thibet—Dr. Hooker's Botanical Mission to India—Proceedings of the Linnæan Society—Proceedings of the Botanical Society—Mr. I. T. Mackay—Notes on the Botany of California—Deodar Cedar.

The article on the Botany of California consists of a notice of Major Emory's Report of the military expedition from Santa Fe to California by the Gila. The writer concludes that the great tree Cactus which makes such a striking appearance, as figured by Major Emory, and which is described by Dr. Engelmann under the name of *Cereus giganteus*, is no other than the well known *Cereus senilis*, or Old-man Cactus of the conservatories.

The notice of the *Deodar* contains an extract of a letter from Dr. Thomson, written from Kashmir; from which, and from other data, the editor "inclines to the opinion that, if the *Deodar* of the Himalaya had been discovered in a locality nearer to that of the *Cedar of Lebanon*, botanists would have considered it only as a variety of that classical tree; and, tracing it, as we can do according to the testimony of

travellers, from Mount Atlas in the west to the chain of Taurus and Altai in the east, we may fairly infer that the same species reaches the Himalaya range, and stretches as far as Kamaon. A. Gr.

3. *Posthumous Papers, bequeathed to the Hon. East India Company by the late* Wm. Griffith, F.L.S., &c., and printed by order of the government of Bengal.—To botanists there is no need of speaking of the loss which science has sustained in the death of Wm. Griffith in early manhood, in the midst of a career, which, with his excellent opportunities, improved to the utmost by his extraordinary talents and industry, was confidently expected to furnish the most important contributions of the age to the advancement of vegetable anatomy and morphology. Had he even survived to prepare for the press the notes and drawings which embody the results of the researches he had already made, these would have had a great influence upon the science. These unfinished materials, with his collections, were bequeathed to the East India Company; the directors of which have caused them to be printed, and a portion of the edition to be distributed among the botanists who are likely to be most benefited by them. The printing is now going on, at Calcutta, under the editorial direction of Dr. John McClelland.

The portion which we have received was printed in 1847, and consists of, 1st. *Journals of Travels in Assam, Burma, Bootan, Affghanistan, and the neighboring countries;* in an 8vo volume of 529 pages, with numerous sketches on stone and a lithographed portrait of Mr. Griffith. 2d. *Notulæ ad Plantas Asiaticas:* Part I. *Development of Organs in Phanerogamous Plants*, pp. 255, 8vo; with an Atlas of 62 large quarto plates, filled with microscopic details, of the highest interest. A. Gr.

4. *Bibliographia Zoologiæ et Geologiæ, &c.;* by Prof. L. Agassiz. Corrected, enlarged and edited by H. E. Strickland. Vol. 1, 1848, pp. 506. Containing the Periodicals, and Alphabetical list of authors for *A.* and *B.* Published by the Ray Society.—This work, the result of many years laborious research, is in course of publication, under the auspices of the Ray Society. The former edition in large folio was printed only for private distribution. The *first part* of the volume just issued, extending to 85 pages exclusive of the preface, is devoted to a list of periodicals and cyclopedias, of which nearly 500 are catalogued, with the date, place of publication, and number of volumes. Under Africa two are cited; Asia 14; Australia 2; New York 12; Philadelphia 13; London 82; Madrid 4; Lisbon 3; Venice 14; Turin 24; Pisa 8; Naples 15; Padua 11; Milan 26; Lausanne 9; Geneva 8; Berne 15; Paris 84; Lyons 12; Caen 10; Brussels 16; Prague 11; Nürnberg 19; Leipzig 45; Halle 15; Berlin 50; Amsterdam 18; St. Petersburg 19; Moscow 9; Copenhagen 26. This will afford an idea of the fullness of this portion of the work.

The *second part* commences with the name of Aalborg, who published two works on bees at Copenhagen in 1639–42. Agassiz himself has a list of 81 works or papers, the first of which bears the date of 1828, and some of his latest contributions have not been included. Audouin is cited for 73 works, papers, &c.; Audubon 11; Bachman 6; J. W. Bailey 7; D. W. Barnes 3; H. Barnes 4; B. S. Barton 17;

Bartram 8; Elie de Beaumont 40; Th. Bell 34; E. T. Bennett 60; Berthold 32; G. Bischoff 19; T. L. W. Bischoff 24; Blainville 150; Blumenbach 41; Boie 39; Bonaparte 49; Boué 67; Brandt 65; Brehm 43; Brocchi 30; Ad. Brongniart 20; Alex. Brongniart 50; Bronn 38; Buch 78: Buckland 61, &c.

A work of this kind must contain examples of various languages (the titles being generally given in the original), and the editor has succeeded in giving the text with remarkable accuracy. In the extensive list of Blainville, No. 127, is a repetition of No. 6. A curious error appears under the name of *W. E. Bach*, which should be *Leach;* this error has doubtless arisen from writing or copying the name from German manuscript, in which one of these names might be readily mistaken for the other.

This work will exercise a wholesome influence upon science, as it will lead authors to a knowledge of the great amount of materials which has accumulated during several centuries. S. S. H.

5. *Observations at the Magnetic and Meteorological Observatory, at the Girard College, Philadelphia, made under the direction of* A. D. Bache, LL.D., *and with funds supplied by the members of the American Philosophical Society, and by the Topographical Bureau of the United States,* 1840 *to* 1845. *Printed by order of the Senate of the U. S., and under the direction of the Topographical Bureau.* Washington, 1847, (issued in 1849,) 8vo, pp. xlix, and 3212, bound in 3 volumes, with Atlas of 210 plates.

The observations recorded and digested in these volumes, were undertaken in compliance with the plan proposed by the British Association for the Advancement of Science. "A great union was thus formed, which finally embraced more than thirty observatories, in the four quarters of the globe, carrying on simultaneous observations upon the same plan and with similar instruments."

It is gratifying that our country has made so valuable a contribution to the progress of this great work, and that the government has with an enlightened liberality assumed the expense of communicating to the scientific world, in a convenient and accessible form, this important mass of materials.

The volumes are introduced by a preface from Dr. Bache, in which he gives a description of the Observatory, the names of the observers and computers, the instruments employed, the modes of observation, and other interesting notices.

We have no room for an extended account of the contents of these volumes, nor is it here necessary, as the work will be sought for and valued by all persons engaged in investigations of the subjects to which they relate. We can not refrain however, from expressing the gratitude of the scientific men of this and other countries to Dr. Bache, and his corps of associates, and also to the Senate of the United States, for this important contribution to the stock of knowledge.

6. *An Introduction to Practical Chemistry including Analysis;* by John E. Bowman, Demonstrator of Chemistry in King's College, London. Philad.: Lea & Blanchard. 1849. 12mo, pp. 303. With numerous wood cuts.—This work is designed for beginners in chemistry, and is a well arranged guide to the common processes of the labora-

tory, including the preparation of the most frequently used reagents. The construction and use of apparatus is also explained, and the manipulations in glass-blowing rendered simple by good cuts.

The action of the most frequently occurring bases and acids with reagents, is also treated of much after the manner of Fresenius, as well also as the outline of qualitative and quantitative analysis. An Appendix contains various useful tables of weights, measures, &c., as also of strength of acids, alkalies, the thermometer, degrees of solubility, &c., to which is added a glossary of terms.

American students are much indebted to Messrs. Lea & Blanchard for the promptness with which nearly every useful work of the English press, on chemistry and other kindred sciences, is reproduced by them.

7. *Gmelin's Chemistry.*—(Hand-Book of Chemistry, by LEOPOLD GMELIN, Professor of Chemistry in the Univ. of Heidelberg, &c., &c. Vol. I. Cohesion—Adhesion—Affinity—Light—Heat and Electricity. Translated by HENRY WATTS, B.A., F.C.S. London: printed for the Cavendish Society, 1848.)—This truly important addition to the chemical literature of the English language, is presented to chemists as one of the offerings of the Cavendish Society, lately formed in London, on a plan similar to that of the Ray Society, and which promises to do for chemical science what the latter has already begun to do so well for natural history. Gmelin's Hand-Book is a work of great erudition, being little else than a complete exposition of all the researches which have thus far unfolded any important truths in chemical science. The first volume now before us (of 519 pages, and 4 copper plates), is exclusively devoted to the physics of chemistry, and will be a rich mine of accurate facts and full references, for many readers, to whom the original German has been a sealed or an inaccessible book. We have been astonished in a rapid review of this volume —at the amount and variety of laborious research and precise statement exhibited in every page which we have read. It is a guide for the teacher and still more for the investigator, rather than a text-book for the student—and as such, will not fail to find its place on the table of all who strive to keep up with the rapid progress of this active day, in which chemistry is advancing with a rapidity known in few other sciences at any period, and unsurpassed by none at present. Did our space permit, we should be glad to transfer to our pages a full conspectus of this valuable volume. Two of the remaining volumes of this system are promised by the Council of the Cavendish Society during this year, if a sufficient addition is made to the number of members.

8. *Transactions of the American Ethnological Society*, vol. ii, pp. 637, 8vo. *New York.*

I. Hon. ALBERT GALLATIN: The Indians of North West America.

II. E. G. SQUIER: Observations on the Aboriginal Monuments of the Mississippi Valley.

III. Prof. C. C. RAFN of Copenhagen: View of the Ancient Geography of the Arctic Regions of America, from Accounts contained in Old Icelandic MSS.

IV. S. G. Morton: Account of a Craniological collection, with remarks on the Classification of some Families of the Human Race.

V. T. Dwight: Sketch of the Polynesian Language, drawn up from Hale's Ethnology and Philology.

VI. A. C. Cotheal: Grammatical Sketch of the Language spoken by the Indians of the Musquito Shore.

VII. S. Wells Williams: Present Position of the Chinese Empire, in respect to the Extension of Trade and Intercourse with other Nations.

VIII. T. Dwight: Sketch of the Mpongwes and their Language, from Information furnished by Rev. John Leighton Wilson, Missionary of the American Board.

Appendix. John R. Bartlett: Progress of Ethnology.

9. *Verhandlungen der Russisch-Kaiserlichen Mineralogischen* Gesellschaft zu St. Petersburg. Jahr. 1847, St. Petersburg, 1848.

Dr. A. von Volborth: On a Russian Trilobite, (Zethus verrucosus,) Tab. i, figs. 5, 6, 7.

A. G. Keyserling: Remarks on the Relations of the Nummulites in Structure.

M. Kositzky: Geological Observations in Northeastern Siberia, made during the years 1844 and 1845.

Prof. L. Zeuschner: Upon a part of the Carpathians.

Dr. C. Grewingk: Geological account of California.—(From published accounts of the Region.)

B. Jerofejew: On the Chalk and Sandstone of the district of Novgorod-Sewersk.—Tab. ii.

N. von Kokscharow: On a new crystalline form of Scapolite, with wood cuts and Tab. iii. Also, on the Crystallization of Uralorthite: Tab. iv and v.

A. G. Schrenk: Minerals of Zylyma (in Petschora).

Dr. Brandt: On the Dodo.

W. von Beck: Chemical analysis of Glinkite.

S. Kutorga: On the Sphonotretæ. Tab. vi and vii. (Includes seven species of Siphonotreta; also the new genera *Schizotreta*, in which the aperture is on the opposite side of the beak from what it is in Siphonotreta, *Acrotreta*, having a high 3-sided pyramidal form and aperture at summit inclining the same way as in Schizotreta; and *Aulonotreta*, corresponding to *Obolus* of Eichwald, and *Ungula* of Pander.)

S. Kutorga: On the Baltic Silurian Trilobites, Tab. viii.

W. Thompson, Esq., Pres. Nat. Hist. and Phil. Soc., Belfast: The Natural History of Ireland. 434 pp. 8vo, vol. I. *Birds: London*, 1849. 16*s*.

Robert Hunt: The Poetry of Science. 8vo, 487 pp. *London*, 1849, 12*s*.

Sir W. Jardine: Contributions to Ornithology for 1848. Three parts, 3*s*. each.

Sir Edward Belcher: Narrative of the Voyage of H. M. S. Samarang in the Eastern Archipelago from Borneo to Korea and Japan. 2 vols., 8vo, 960 pp. 35 charts, plates and etchings. *London*. 36*s*.

George Gardner: Travels in the Interior of Brazil during the years 1836–1841. 1 thick vol., 8vo. *London*. 18*s*.

Dr. Harvey: History of British Seaweeds. Part 39. Six colored plates. 2*s*. 6*d*.: large paper 5*s*. *London*.

Lovell Reeve: Conchologica Iconica—Demy 4to. Part 72. Eight colored plates: 10*s*. Uncolored Issue, Part 12, six plates, 2*s*. 6*d*. *London*.

Mrs. Hussey: Illustrations of British Mycology, with colored drawings. Part 24. Royal 4to. *London.* 5s.

J. D. Hooker: Rhododendrons of the Sikkim-Himalaya. Imp. folio; with ten colored plates. *London.*

Dugald Campbell: Practical Text-Book of Inorganic Chemistry, with Qualitative and Quantitative Analysis. *London*, 1849.

J. J. R. Jackson: Minerals and their uses, in a series of Letters to a Lady. *London*, 1849.

Charles Wilkes, U. S. N., Commander U. S. Expl. Exped. 1838–1842: Western America, including California and Oregon, with maps of the region and of the Sacramento Valley.

E. Forbes: Monograph of the British naked-eye Medusæ. 104 pp., with 13 colored lithograph plates. *London.* 1848.

Alder & Hancock: Monograph of British Nudibranchiate Mollusca. 12 pl. *London.* 1848.

The Western Boatman: a monthly periodical, published at Cincinnati, devoted to navigation, and containing a steamboat directory, and a registry of pilots and engineers; by D. Embree. March, 1849, Vol. I, No. 9. This number contains a valuable article on steam and steam explosions, by the editor.

Report of Prof. Alexander D. Bache, Superintendent of Weights and Measures, for 1846–1847. Executive Document, No. 73, Senate, 30th Congress, 1st session. Ordered to be printed, Aug. 12, 1848.

W. E. Logan: Geological Survey of Canada: Report on the north shore of Lake Huron. 47 pp., 8vo, with two maps. *Montreal*, 1849. Mr. Logan in his valuable report states that there are twenty-two mining stations on the north shore of Lake Huron, recognized and claimed by the English, the principal of which, Bruce's Mines, are situated under the meridian of 84°.

Determination of the Latitude with Zenith and Equal Altitude Telescope.—Published under the direction of the Topographical Bureau of the War Department. Paper No. 2. *Washington*, 1849.

Proceedings of the American Academy of Arts and Sciences at Boston, Jan. 1849.—A discussion of the observations on the planet Metis, with a determination of its orbit, accompanied by a computation of the subsequent perturbations of the orbit and an ephemeris; *B. A. Gould, Jr.*

Proceedings of the Acad. Nat. Sci. of Philadelphia, vol. iv.—AUGUST, 1848, p. 75. On four skulls of Shoshonee Indians; *S. G. Morton.*—p. 77. Description of a new Mexican quail (Ortyx thoracicus); *Wm. Gambell, M.D.*—Dipodomys agilis and Mus californicus, two new Californian Quadrupeds; *Wm. Gambell.*—OCTOBER. p. 85. A new Tanagra (T. nigro-aurita) from Rio Negro, S. A.; *J. Cassin.*—p. 86. Notes of the post-mortem appearances observed in a Cynocephalus porcarius; *E. Hallowell.*—p. 87. Catalogue of birds collected between Vera Cruz and City of Mexico; *Wm. H. Pease.*—p. 81. On the Geology and Natural History of Mexico; *Wm. H. Pease.*—p. 95. Catalogue of the tertiary testacea of the United States; *H. C. Lea.*—DECEMBER. p. 116. On the development of the Purkinjean corpuscle in bone; *J. Leidy.*—p. 117. On the intimate structure of articular cartilage; *J. Leidy.*—p. 119. On the arrangement of the areolar sheath of muscular fasciculi and its relation to the tendon; *J. Leidy.*—p. 121. Descriptions of two new genera (Parapholas and Cryptomya) and new species of recent shells, &c.; *T. A. Conrad.*—p. 121. Descriptions of four new owls (Ephialtes sagittatus, E. Watsonii, Syrnium albo-gularis, and S. virgatum), the last three from South America; *J. Cassin.*—p. 126. Salamandra lugubris, a new species; *E. Hallowell.*—Contributions to American Ornithology, (including two new species of Sterna); *W. Gambel.*—p. 130. Report of Librarian.—p. 132. Report of the Curators.—JANUARY. p. 145. On the existence of the intermaxillary bone in the embryo of the human subject; *J. Leidy.*—FEBRUARY. p. 151. Notes of the post-mortem examination of a Cynocephalus; *E. Hallowell.*—p. 152. New fresh water and marine shells, (Unio 9 species, Margaritana 1, Melania 5, Solecardia (new gen.) 1, Petricola 1, Cyathodonta (new gen.) 1, Pholadopsis (new gen.) 1, Parapholas 1, Penitella 1, Tritor 1, Oliva 1); *T. A. Conrad.*—p. 157. New species of Nyctate and Syncobius; *J. Cassin.*—p. 158. Notes on the Vulturidæ and Strigidæ in the collection of the Academy; *J. Cassin.*—Catalogue of the Vulturidæ in the collection of the Academy; *J. Cassin.*

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